DOCUMENT RESUME

ED 242 557 SE 044 358

TITLE	Adult Basic Education Science Curriculum Guide.
INSTITUTION	British Columbia Dept. of Education, Victoria.
PUB DATE	83
NOTE	312p.; For Mathematics Curriculum Guide see SE 044 352.
PUB TYPE	Guides - Classroom Use - Guides (For Teachers) (052)
EDRS PRICE	MF01/PC13 Plus Postage.
DESCRIPTORS	*Adult Basic Education; *Biological Sciences; Computer Literacy; *Curriculum Design; Curriculum Development; Curriculum Guides; Earth Science; Foreign Countries; General Science; *Physical Sciences; Science Activities; *Science Curriculum; Science Education; *Science Instruction; Teaching Methods; Units of Study
IDENTIFIERS	British Columbia

ABSTRACT

This seven-part guide is intended for use in defining curricula for a wide clientele of adult learners in British Columbia who want to improve their knowledge, skills, and understanding in science. Part 1 explains the guide's place in the provincial curriculum development and articulation processes, defines the three purposes of the guide, outlines the scope of the curriculum, and provides an overview of curriculum goals and instructional units. Part 2 begins with a perspective of the current and future needs of Adult Basic Education (ABE) Science followed by guidelines for specific program and course planning, with representative course designs. Parts 3, 4, and 5, respectively, contain samples of fundamental, intermediate, and advanced instructional units. Each unit contains a topic outline, purpose statement, identification of required background, key ideas, learning objectives and activities, and list of resources. Subject areas considered include general science, biology, chemistry, physics, and earth science. Part 6 presents a variety of ideas to consider in planning ABE science instruction. Brief sections on principles of adult learning, advising and placing students, and student evaluation are included. Part 7 contains sections on laboratory, print, and audiovisual resources; lists of professional references; and addresses of publishers and suppliers. (JN)

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Adult Basic Education

Science

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Ministry of Education

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ADULT BASIC EDUCATION

SCIENCE

CURRICULUM GUIDE

Province of British Columbia
Ministry of Education
1983

ACKNOWLEDGMENTS

The Ministry of Education acknowledges the work of the following people who have contributed to the production of this guide:

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Special thanks are also extended to Dennis Johnston and Harry Mchlman, Selkirk College, for the computer literacy unit; to members of the Adult Basic Education Association of British Columbia, for many valuable suggestions; and to the College of New Caledonia for their co-operation in administering the project.

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THE PLAN OF THIS BOOK

This curriculum guide is divided into seven distinct parts for ease of use and reference.

Part 1 Using the Curriculum Guide first explains the place of the guide in the provincial curriculum development and articulation processes. Three purposes of the guide are then defined. Next, the scope of the curriculum is outlined, followed by the overview of curriculum goals and instructional units. Finally, a list of sample units is included.

Part 2 Curriculum Design begins with a perspective of the current state and future needs in ABE Science, which guided the overall design of this curriculum. The following section provides instructors and programmers with guidelines for specific program and course planning, and includes representative course designs.

Parts 3, 4, and 5, respectively, contain samples of **Fundamental, Intermediate, and Advanced Instructional Units**. Each unit contains a topic outline, purpose statement, identification of required background, key ideas, learning objectives and activities, and a list of resources.

Part 6 Approaches to Teaching and Learning presents a variety of ideas for instructors to consider in planning ABE science instruction. This part includes brief sections on principles of adult learning, advising and placing students, and evaluation of student progress.

Part 7 Selected Resources contains sections on laboratory, print, and audio-visual resources, lists of professional references, along with addresses of publishers and suppliers.

The final pages of the book constitute the 'response form', which users are requested to return to the Ministry with their comments.

CURRICULUM GUIDES AND PROGRAM ARTICULATION

This document is one of a series of adult basic education curriculum guides issued by the Continuing Education Division of the Ministry of Education. The guides cover the areas of English and Communications, Mathematics, and Science, from the end of basic literacy through secondary school completion or equivalent.

It is intended that a wide variety of courses including ABE 3, ABE 4, college preparation, and secondary school courses for adults will be developed or revised within the framework of the curriculum guides. For this purpose, each guide contains a section on course design, including samples of a range of representative courses. Specific course content or textbooks are not, however, prescribed by the guides.

Over the past two years, several groups have suggested to the Ministry that an articulation of ABE curriculum and certification should be accomplished. Specifically, in the Spring of 1983, the project advisory committees for both the Science and Mathematics curriculum guides recommended that "the Ministry should initiate a process to address provincial articulation concerns of the ABE curriculum in Science, English and Communications, and Mathematics...".

Consequently, during the year 1983/84, the Ministry of Education plans to initiate a consultative articulation process for adult basic education programs. Expected outcomes of this process are as follows:

- rationalization of program and course titles;
- establishment of certification criteria;
- consensus on appropriate balance of subjects within a program.

The articulation process will involve consultation with a broadly based committee drawn from institutions involved in the delivery of adult basic education. The three ABE curriculum guides produced to date will be an important part of the 'working papers' of the committee. It is expected that this activity will, among other benefits, improve transferability of ABE students between institutions.

Meanwhile, this guide is being distributed as a 'Response Draft'. This step in the curriculum development process provides further opportunity for practitioners to examine, discuss, and comment on this major area of adult learning.

Written comments and suggestions should be sent, either on the sheet at the end of this book, or separately, to:

Co-ordinator, Adult Basic Education
Continuing Education Division
Post-Secondary Department
Ministry of Education
Parliament Buildings
Victoria, B.C. V8V 2M4 by March 31, 1984.

It is the hope of the Ministry of Education that instructors, administrators, and representative groups will take this opportunity to provide the 'response from the field' that will improve the effectiveness and use of this document.

Ron Faris
Executive Director
Continuing Education Division

PURPOSES OF THE GUIDE

This guide has three specific purposes. The first is to define a contemporary perspective on science education in ABE programs, which embraces not only the recent trends in science education generally, but also the major goals of ABE students.

The second purpose is to present a flexible structure for course design, which can accommodate the following:

- selection and adaptation of science curriculum so that it is appropriate to adult interest and need;
- organization of science topics into manageable units of study for instruction and evaluation;
- an appropriate balance of emphasis on skills and processes of science, knowledge of substantive information, understanding of key ideas and their application, development of critical thinking about issues of science in the context of society;
- learning individually, co-operatively, or in a larger group;
- on-campus instruction, outreach classes, or in a distance learning mode;
- potential for use with various texts and other resources, which might be changed from time to time without major expense or other problem (e.g., not keyed exclusively to one text).

The third purpose is to provide administrators, co-ordinators, and instructors with a framework that may assist them to:

- co-ordinate courses within an institution;
- articulate courses among institutions in the province;
- assess and certify levels of student achievement;
- define curriculum development needs;
- define professional development needs.

It should be noted that it is not the purpose of this guide to articulate course titles, levels, or standards, but rather to provide a basic resource for those who may become involved in such a process.

SCOPE OF THE CURRICULUM

This curriculum is intended for adult learners who have achieved a level of competence in English and mathematics that is beyond basic literacy and numeracy. The upper limit of the curriculum range may generally be taken as secondary school completion or equivalent.

Current titles of courses within this range include ABE/BTSD levels 2, 3, and 4, College Foundations or College Preparatory Science, Science 9/10, and Biology 11/12, Chemistry 11/12, Physics 11/12, Earth Science 11, and Geology 12 in the adult secondary school program.

The primary approach of this guide, however, is to define a curriculum for a wide clientele of adult learners who want to improve their knowledge, skills, and understanding in science.

Thus, with a few exceptions, grade levels and conventional course titles have not been referred to in this guide. Instead, the instructional units have been selected and designed to provide the 'building blocks' for courses and programs appropriate to the goals of this science curriculum:

* Science for the Individual,
* Science for Career Preparation,
* Science for Employment,
* Science for the Citizen.

OVERVIEW OF CURRICULUM GOALS AND INSTRUCTIONAL UNITS

The curriculum goals and sample instructional units were established by the curriculum development team on the basis of:

- a survey of the current state and future needs in ABE Science (summarized as 'Perspective on ABE Science' in Part 2 of this guide);
- directions from a field-based, provincial advisory committee;
- consultation with a field review panel of ABE science instructors;
- current trends in science education.

The sample instructional units are categorized as Fundamental, Intermediate, or Advanced.

Fundamental units are those that provide a basic foundation for further science learning and probably should be included in any science course.

Intermediate units are those that require little or no previous science background and are divided into General, Biology, Chemistry, and Physics groups.

Advanced units are those generally requiring some previous science background and are often designed to follow intermediate units. They are divided into General, Biology, Chemistry, Physics, and Earth Science groups.

Each sample unit indicates suggestions for:

Topics,
Purpose (of the Unit),
Required Background,
Key Ideas,
Sample Learning Objectives,
Sample Learning Activities,
Resources.

Part 2 of this guide recommends ways in which the instructional units may be selected and grouped in order to meet the curriculum and learner goals.

The sample units themselves are contained in Parts 3, 4, and 5. It should be emphasized that these are sample, or prototype, instructional units. Instructors and institutions are encouraged to develop and articulate other units that would fit the general framework of this curriculum guide.

CURRICULUM GOALS

The four goals presented in this section are seen as having equal importance for curriculum planning. However, the relative emphasis on each goal will vary within courses depending on the educational objectives of learners. For each goal, a number of illustrative learning opportunities are listed.

GOAL A: Science for the Individual

Empower adults with the knowledge and ability to use science for improving their personal and family lives and for coping with the technology of modern society.

Opportunities, for example, should be provided to:

- develop the abilities needed to be an effective consumer and to maintain personal and family health;
- develop the ability to use science in making everyday decisions and solving everyday problems;
- use scientific knowledge and skills to help clarify personal values and beliefs.

GOAL B: Science for Career Preparation

Provide adults who may plan vocational and career education related to science or technology with the appropriate knowledge, skills, and orientation.

Opportunities, for example, should be provided to:

- understand the relationships between the various disciplines of science, and between science and other fields of knowledge;
- study and, where possible, apply the major concepts and principles of science;
- develop the skills necessary for laboratory experiments, and for the safe handling of equipment and materials;
- develop understanding of these basic processes of science.

  observing
  classifying
  defining
  inferring
  integrating
  predicting
  formulating hypotheses
  designing & setting up experiments
  controlling variables
  interpreting data
  communicating results
  applying knowledge

GOAL C: Science for Employment

Provide adults with the knowledge, skills, and understanding that will enhance their roles as employees or employers, whatever their occupation.

Opportunities, for example, should be provided to:

- study and apply fundamental principles of science and technology that increase the productive power, safety, and satisfaction of the worker;
- evauate practical applications of science and technology in the workplace;
- examine typical problems faced by producers of goods and services, and the contributions offered by science for problem solutions;
- increase awareness of the many possible roles and jobs available in science and technology, and of the contributions persons in such jobs can make to society.

GOAL D: Science for the Citizen

Provide adults in their roles as citizens and community members with the background they need to understand societal issues related to science and technology.

Opportunities, for example, should be provided to:

- evaluate information and opinions on science and technology issues in order to judge the consistency of arguments presented; recognize stereotypes, cliches, bias, and emotional factors; identify essential, relevant, and verifiable data; judge the validity of conclusions; assess alternate solutions to problems;
- study the impact of technological change on society;
- examine various aspects of environmental issues;
- obtain a basic understanding of scientific and technological principles that will enable a person to understand societal and environmental issues.

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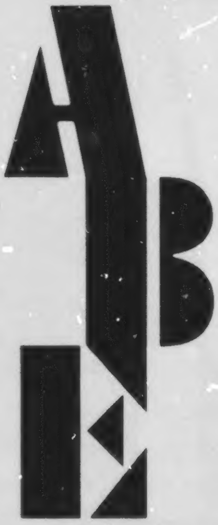
A
B
E

PERSPECTIVE ON ABE SCIENCE

Science represents a major component of most Adult Basic Education programs in the colleges, school districts, and institutes of British Columbia. Courses are offered at central campuses, at isolated satellites, and through distance learning. They are often available both day and night, and for both full-time or part-time learners. Instruction may be by conventional, classroom lecture/ laboratory methods, by individualized tutoring, in learning centres by a self-paced, modular method, or by these and other methods in combination.

While a review of current course offerings in ABE Science revealed this diversity, it also discovered a need for definition and clarification of the common ground in the curriculum. A recurrent theme voiced by practitioners was the need for a clearly defined, province-wide curriculum that would provide guidance in discussions and decisions about course content, standards, certification, transfer of student credit, and general program articulation and co-ordination.

In its investigations into the current state and future needs of ABE Science, the curriculum development team was able to draw on the experience and advice of three groups of practitioners. A broadly based advisory committee included representatives from colleges, school districts, and both the Post-Secondary and Schools departments of the Ministry of Education. The advisory committee provided project guidelines and reviewed major drafts. A field review panel drawn from six different institutions provided specific feedback on curriculum content and arrangement. (The membership of these groups is shown in the Acknowledgments section of this guide). Also valuable were the suggestions of participants in an instructor's workshop held in co-operation with the Adult Basic Education Association of British Columbia in March, 1983.

The present emphasis of science in the adult basic education program tends to be based on one or more of these concepts:

* Science as a pre-vocational study, a concept with historic roots in the former B.C. vocational schools;

* Science as academic upgrading, either as an extension of secondary school science, or as preparation for university credit and career program science;

* Science as general education, a more recent emphasis with broader, less defined goals such as environmental awareness and scientific literacy.

Along with this background of the varying aims of the current ABE Science curriculum, the development team also found useful an approach recently outlined in a working paper on curriculum development in ABE (B.C. Ministry of Education, 1983). The model analyzes adult learning needs in the context of six societal roles.

These are the roles defined for the purpose of curriculum development and design.

Family Member
Consumer
Community Member
Citizen
Worker
Learner

In each of these life roles, adults continually face a range of developmental tasks, often looking to the education systems for learning opportunities. Their expressed learning needs reflect not only their own interests, but also the changing expectations of society.

The role of learner is particularly critical. It may serve as an adjunct to one of the other roles; moreover, it may also set the context for an individual's fundamental desire for personal growth and intellectual development, independently of other social role expectations.

For the purpose of the ABE Science Curriculum Guide, it was found practical to consolidate the curriculum goals into the form in which they appear in Part 1.

Goal A: Science for the Individual (family member and consumer roles)
Goal B: Science for Career Preparation (worker and learner roles)
Goal C: Science for Employment (worker role)
Goal D: Science for the Citizen (citizen and community member roles).

Practitioners familiar with other ABE subject areas will observe similarities between the application of the 'social role' model here, and in the ABE Mathematics Curriculum Guide and (ESL) English for Work (B.C. Ministry of Education 1983, 1982).

Proceeding from these goal statements, there are still an infinite number of ways an adult science curriculum might be organized. The present draft curriculum is proposed as a workable blend of the following features:

- A middle ground between the subject-centred, discipline-oriented curriculum, and the experience-centred curriculum;

- An integrated curriculum with emphasis on 'key ideas' and themes;

- A recognition of the growing need to relate science and technology to the everyday concerns of the adult as a member of both a local and a world community;

- A potential for adaptation of the instructional units to a variety of delivery methods, as well as to a range of approaches and philosophies of science educators;

- A form of curriculum organization that is readily accessible and understandable to the majority of science instructors who are accustomed to finding science topics listed under the long-established headings of Biology, Chemistry, Physics, and Earth Sciences.

The general orientation of this guide was also strongly influenced by a number of recent publications of science educators in Canada and the United States. The most notable are a group of monographs of the Science Council of Canada (1979, 1980, 1983), a special report of the (U.S.) National Science Teachers' Association (1981), and, not least, the new integrated curriculum for Junior Secondary Science in the B.C. school system (B.C. Ministry of Education, 1982). These publications are listed in Part 7 of this guide, the Professional Reference section.

In summary, it is the aim of this guide to recognize and respond to the variety of adult motives for learning about science, to reflect the trends of contemporary science education while preserving the traditional roots of ABE science teaching, and to provide an adaptable model for use in the changing Canadian and world society of the 1980s.

This section describes a step-by-step approach to planning an ABE Science course (or program of courses) using key parts of the curriculum guide. In this process, information about students and instructional resources is taken into account as selected units of study are arranged into courses. It is expected that instructors and departments will modify the planning steps to suit their local needs.

Step 1: Become Familiar with the Guide

Of particular value will be the sections entitled 'The Plan of This Book', 'Perspective on ABE Science', 'Overview of Curriculum Goals and Instructional Units', and the 'List of Sample Units'. It would be worthwhile to skim the Fundamental, Intermediate, and Advanced Units and perhaps read one or two units in more detail to understand the way in which the unit outlines have been organized.

Step 2: Identify Student Goals and Needs

Consider the main groups of students represented in your ABE program. What are their personal or social goals and needs? The section on curriculum goals may be useful at this point, as it identifies four general directions for science courses: science for the individual, for career preparation, for employment, and for the citizen. Thus, a typical ABE student population may include (a) one group of people interested in learning about science for personal interest, (b) other groups requiring science knowledge and skills in preparation for further vocational or career training (including college or university), (c) another group seeking basic scientific understanding for their work, and (d) yet another group whose goals are less defined but who seek some type of upgrading certificate at a Grade 10 or 12 level.

Each group will have certain specific needs, but often there will be requirements common to more than one.

Step 3: Analyse Local Resources and Constraints

These resources and constraints may be grouped generally under the headings of personnel, physical, financial, and time.

Personnel: Consider the professional background, experience, and interest of the instructor(s). How might these be supplemented or supported? Other resource people may be available, for example, in the institution or from the community.

Physical: Appraise the existing supply of textbooks, equipment, laboratory facilities, and other physical resources. Identify local community resources, including libraries, parks, hospitals, industrial laboratories, and natural environments.

Financial: Capital and operational budgets will establish limits on the purchase of textbooks, equipment, materials, as well as the expenses of field trips, film rentals, and honoraria for speakers.

Time: Either in the form of instructor preparation or professional development, time may be a limiting factor to course development. On the other hand, if the present curriculum generally meets provincial guidelines, only a small amount of reorganization may be required. New units may be added or existing units improved as resources permit.

Step 4: Determine the Science Courses to be Offered

This decision will probably be made at the department or institutional level. The purpose and broad content of each course should be identified, along with course prerequisites and required course sequences. Articulation of courses within and outside the institution should be clearly defined.

Step 5: Establish the Number and Type of Units in Each Course

This decision too, will probably be an institutional one. The sample units outlined in this curriculum guide are designed to be flexible in terms of length and depth of treatment. They may be adapted for use in variously titled courses such as ABE Level 3, Level 4, Science 10, GED Science, Biology 11/12, Chemistry 11/12, Physics 11/12, or College Preparatory. Most courses would probably consist of one or more Fundamental Unit(s) and a selected number of Intermediate or Advanced Units

Step 6: Select the Course Units and Identify Instructional Resources and Evaluation Standards

There are many ways that the sample units developed for this guide might be combined into courses for groups of students, or even for individuals. It is expected that institutions may modify and add to the range of units that has been presented.

Instructional resources will also vary locally. Evaluation procedures and standards should be equally clear to instructors and students (see also Part 6 of this guide). This section concludes with a number of representative course designs, applying course titles commonly in use in the province at the time of writing.

REPRESENTATIVE COURSE DESIGNS

A Level 3 Course with General Science Emphasis

This course in intended

- for students seeking a Grade 10 certificate or ABE Level 3 certificate;
- as preparation for the G.E.D. examination, business occupations, or a general knowledge of science for personal interest.

Unit Selection

As indicated in Design of Programs and Courses, Step 5, the decision regarding the number and type of units for each course will probably be an institutional one. However, the following selection suggestions may be of help to instructors.

Fundamental Units

Three of the four fundamental units are suggested for this course.

- Skills and Processes of Science
- Computer Literacy
- Science and Technology (could be effective as final unit of course)

Intermediate Units

Choose five to seven units from the General Science and Biology groups, including Consumer Chemistry or Astronomy.

Advanced Units

One unit might be included, depending on the goal, background, and ability of the student(s). Unit prerequisites should be noted.

A Level 3 Course with Life Science Emphasis

This course is intended for:

* students with future goals in health and human service fields, who may or may not plan to take more advanced Science courses.

Unit Selection

The following units are suggested for this course.

Fundamental Units

Three of the fundamental units are suggested.

* Skills and Processes of Science
* Computer Literacy
* Science and Technology (could be effective as final unit of course)

Intermediate Units

Choose five to seven from the following list.

* The Cell: Basic Unit of Life
* Chemistry: Introduction
* Classification and Diversity of Life
* Disease
* Drugs and Their Use
* Ecology
* Food and Nutrition
* Human Biology
* Human Development and Behavior
* Individual Disabilities
* Reactions and Equations

A Level 3 Course with Physical Science Emphasis

This course is intended for:

- students with future goals in technical areas, who may or may not plan to take more advanced courses.

Unit Selection

The following units are suggested for this course.

Fundamental Units

All four fundamental units are recommended.

- Skills and Processes of Science
- Computer Literacy
- Properties of Materials and Atomic Structure
- Science and Technology (final unit)

Intermediate Units:

Choose four to six units from the following list.

- Astronomy
- Chemistry: Introduction
- Earth Science
- Ecology
- Electric Circuits
- Energy
- Environmental Control
- Environmental and Waste Management
- Reactions and Equations
- Simple Machines
- Soil Chemistry
- Waves: Light and Sound
- Work, Home, and Recreational Safety

A Level 4 Course with General Science Emphasis

This course is intended for:

* students who are studying science for personal interest, or

* students who may require a Grade 12 Equivalency (GED) Certificate.

Unit Selection

The following units or prerequisite knowledge are suggested.

Fundamental Units

Select the following two units unless the student has equivalent prerequisite knowledge.

* Skills and Processes of Science
* Computer Literacy

Intermediate

Students should satisfy prerequisites for advanced units; alternatively, choose two units not already studied.

Advanced:

Choose four to six units form this list.

* Contemporary Issues in Science
* Earth Resources
* Historical Geology
* Human Growth and Reproduction
* Human Inheritance

A Level 4 Course with Life Science Emphasis

This course is intended for:

- students with future plans in health or human service fields requiring Grade 12 or equivalent.

Unit Selection

The following units or prerequisite knowledge are suggested for this course.

Fundamental Units

Select the following two units unless the student has equivalent prerequisite knowledge.

- Skills and Processes of Science
- Computer Literacy

Intermediate and Advanced Units:

Select six to eight units from the following list.

(Intermediate)

- The Cell: Basic Unit of Life
- Classification and Diversity of Life
- Environmental Control
- Reactions and Equations

(Advanced)

- Acids, Bases, and Salts
- Biochemistry
- Body Systems 1: Movement and Control
- Body Systems 2: Internal Processes
- Contemporary Issues in Science
- Human Growth and Reproduction
- Human Inheritance
- Oxidation and Reduction
- Plant Systems and Functions
- Plant and Animal Diseases
- Solutions

A Level 4 Course with Physical Science Emphasis

This course is intended for:

- students with future plans in technical fields requiring Grade 12 or equivalent.

Unit Selection

The following units or prerequisite knowledge are suggested for this course.

Fundamental Units

Select the following three units unless the student has equivalent prerequisite knowledge.

- Skills and Processes of Science
- Properties of Materials and Atomic Structure
- Computer Literacy

Intermediate and Advanced Units:

Select five to eight units from the following list.

(Intermediate)

- Electric Circuits
- Energy
- Reactions and Equations
- Simple Machines
- Soil Chemistry

(Advanced)

- Acids, Bases, and Salts
- Contemporary Issues in Science
- Electro-magnetism
- Historical or Physical Geology
- Mechanics and Motion
- Nuclear Chemistry
- Oxidation and Reduction
- Solutions

Biology 11/12 Course Comparisons

Biology 11 (Schools)

Ecology
Diversity
Evolution
Option

Biology 11 (ABE)

Skills and Processes of Science
Computer Literacy

Ecology
Environmental Control
Environmental and Waste Management
Energy

Classification and Diversity of Life
Plant Systems and Functions
Biochemistry

Contemporary Issues in Science

Biology 12 (Schools)

Physiology
Cellular Biology
Evolution
Option

Biology 12 (ABE)

The Cell: Basic Unit of Life
Body Systems 1: Movement and Control
Body Systems 2: Internal Processes
Human Inheritance
Human Growth and Reproduction
Biochemistry
Contemporary Issues in Science

Chemistry 11/12 Course Comparisons

Chemistry 11 (Schools)

Scientific Method
Description of Matter
Classification of Matter
A Theory of Matter
Mole Concept
Electrical Nature of Matter
Periodic Table
Nuclear Chemistry

Chemistry 11 (ABE)

Skills and Processes of Science
Properties of Materials
Chemistry: Introduction
Reactions and Equations
Energy
Nuclear Chemistry

Options

Consumer Chemistry
Soil Chemistry
Biochemistry
Contemporary Issues in Science

Chemistry 12 (Schools)

Oxidation and Reduction
Chemical Energetics and Equilibrium
Acids, Bases, Salts in Water

Options

Structure and Bonding
Modern Methods of Chemical Analysis

Chemistry 12 (ABE)

Oxidation and Reduction
Acids, Bases and Salts
Solutions

Options

Biochemistry
Earth Resources
Environmental and Waste Management
Soil Chemistry
Contemporary Issues in Science

Physics 11/12 Course Comparisons

Physics 11 (Schools)

Motion in One Dimension
  Kinematics
  Dynamics
Special Relativity

Mechanical Energy
Heat Energy
Electical Energy
Nuclear Energy

Wave Phenomena
Quantum Theory of
 Atomic Structure

Options

Applied Optics
Sound
Human Body Physics
Energy
Particle Physics
Astrophysics

Physics 11 (ABE)

Mechanics and Motion
Electric Circuits

Nuclear Chemistry
Waves: Light and Sound
Simple Machines
Astronomy
Contemporary Issues in
 Science

Physics 12 (Schools)

Vectors
Motion in Two Dimensions
Universal Gravitation
Charges and Currents
Electromagnetism

Options

Electronics
Quantum Physics
Fluid Dynamics
Kinetic Theory of Gases
Biophysics
Geophysics

Physics 12 (ABE)

Electromagnetism
Mechanics and Motion

Options

Physical Geology
Contemporary Issues in
 Science

DEFINITION, EXPLANATION, AND INDEX OF UNITS

Definition

Fundamental units are those that provide a basic foundation for further science learning and probably should be included in any science course.

Explanation

Each sample unit contains information listed under these headings:

Topics,
Purpose (of the unit),
Required Background,
Key Ideas,
Sample Learning Objectives,
Learning Activities,
Resources.

Instructors should note that the number of activities related to one objective may vary. Neither the substance nor the order of the activities should be considered prescriptive; rather, instructors are encouraged to determine the selection and organization of activities according to the goals of the learners.

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SKILLS AND PROCESSES OF SCIENCE

Topics

What is Science?
Methods Used by Scientists
Measurement
Lab Orientation - Safety Procedures and Lab Skills

Purpose

The purpose of this unit is to provide students with the fundamental skills and knowledge of processes they will require before studying intermediate or advanced units in ABE Science. For example, students will learn to use several observational tools of science; to acquire a knowledge of ways to organize observations and draw conclusions; to be able to make hypotheses; and to communicate information.

In addition, the unit will emphasize these points.

1. Labs can be used to demonstrate an idea or concept, or to investigate some phenomenon in a scientific manner.

2. Information may be handled in numerous ways once it has been collected.

3. The International System of Units (SI) is the recognized system of measurement used in scientific studies.

Required Background

None.

Key Ideas

- The scientific process includes knowledge of and ability to use manipulative processes, integrative processes, and safety procedures.

- The standard laboratory procedure consists of five basic steps, which could be further subdivided at the discretion of the instructor:

  1. stating the question or formulating a hypothesis;
  2. planning and organizing the experiment;
  3. conducting or carrying out the experiment, i.e., doing, seeing, adjusting and controlling variables, and recording observations;
  4. concluding or summing up, i.e., deriving an answer from an experiment and predicting or going beyond the conclusions;
  5. Communicating results (including support or rejection of hypothesis), and thereby increasing scientific knowledge.

- These steps may be repeated when the results of a completed experiment indicate that further investigations are necessary.

- Methods of organizing data include listing, graphing, tabulating, classifying, and estimating.

- The SI system is used in science.

- Accuracy in measuring and recording scientific data is essential in lab work, as well as an understanding of one's least accurate measurement.

SAMPLE LEARNING OBJECTIVES

Learning opportunities should be set up to enable students to accomplish the following objectives.

1. Approach lab tasks with an open mind, and explain how similar procedures may be applied to the solution of other questions outside the lab.

2. Investigate and learn the integrative process of science, which includes:

   data interpretation,
   formulation of hypotheses,
   control of variables,
   experimentation,
   drawing conclusions,
   going beyond the conclusions,
   communicating.

3. Organize observations so that regularities may be discovered through manipulative processes such as: listing, graphing, tabulating, classifying, and estimating.

4. Demonstrate ability to record and communicate information accurately with the SI system.

LEARNING ACTIVITIES

Complete a number of activities using the SI system, to measure and calculate quantities such as length, mass, area, volume, density, and speed; e.g., use correct SI units to determine the area of the classroom, counters, or tables; volume of aquaria, coffee cups, beakers, or teaspoons; heights of students, hand-spans, or footlengths; diameter of coins or pencils; temperature of the classroom; distance from the earth to the sun.

Plot relevant data from the above, or similar activities that show a relationship or pattern in the data. This should increase awareness of alternate ways of viewing the same phenomena; e.g., mass vs. volume; distance vs. time; height vs. foot length. Additional activities may be found in Dean, Operations of Science, especially:

Activity 7 Measurement,
Activity 11 Functions,
Activity 4 Classification,
Activity 5 Balancing.

Perform several simple experiments using the standard lab procedure to test a hypothesis, i.e., a "closed-type" lab that answers a specific question through experimentation and does not lead to further investigation.

SAMPLE LEARNING OBJECTIVES	LEARNING ACTIVITIES
5. Practise safety rules in the laboratory and use the correct safety procedures when handling laboratory equipment or hazardous materials; develop an attitude of personal safety and respect toward fellow workers.	What happens to air when it is heated? Is black ink made from a single black dye or several different dyes? How does the temperature of water change as chemicals are added to it? How much air is in sand?
6. Be open to integrating the ideas of others into one's understanding and attitude about science.	Using labs and activities from Principles of Science or Operations of Science (Activity 2 - Experimenting Activity 3 - Science): Complete a series of experiments on related topics, i.e.,: "open-type" labs that answer a specific question through experimentation but also can lead to further investigation based on the results and conclusions. Activities might inlcude formulation of new hypotheses, predictions or inferences beyond the conclusions. Use control and experimental groups to test the effect of a number of variables, e.g., growth of bean seeds in different wavelengths of light spectrum, or swing of a pendulum by varying the length of string or the weights. See also Operations of Science (Activity 12 - Hook's and Gas Laws, Activity 13 - Ohm's Law). Discuss the roles of scientists in society. Explain situations when a specific approach would be beneficial in solving problems, and identify other situations where a strictly scientific approach would have limitations.

Resources

Texts

Heimler and others. *Focus on Science* series.

Heimler and Neal. *Principles of Science: Book 1 and 2.*

Other Books

Agnew, Neil McK., and Sandra W. Pyke. *The Science Game.* Englewood Cliffs, N.J.: Prentice-Hall, 1969.

Aikenhead, Glen S. *Science in Social Issues - Implications for Teaching.* Ottawa: Science Council of Canada, 1980.

Dean, Geoffrey. *Operations of Science: Student's and Instructor's Guides.* Victoria, B.C.: Ministry of Education, 1979.

Individualized Science Instructional System (ISIS). "The Ways We Learn" Module. Lexington, Mass.: Ginn, 1979.

Munby, Hugh. *What is Scientific Thinking?* Ottawa: Science Council of Canada, 1982.

Periodical Articles

Cole, K.C. "Beyond Measurement." *Discover*, 4, No. 10 (October 1983), 68. In science, measurement is usually a means to an end.

———. "On Right and Wrong." *Discover*, 4, No. 9 (September 1983), 48. How to tell right from wrong in science.

Gorman, James. "Scientist of the Year: Stephen Jay Gould." *Discover*, 3, No. 1 (January 1982), 56. Profile of Harvard's evolutionary theorist and his opposition to views of 'creationism'.

McKean, Kevin. "Genetics, Grapes and the Good Life." *Discover*, 4, (October 1983), 36. Profile of Scientist Francisco Jose Ayala.

Thomas, Lewis. "On Science and 'Science'." *Discover*, 3, No. 1. Science and technology are defined.

COMPUTER LITERACY

Topics

What is a Computer?
Language and Terminology of Computing
Introduction to Programming
Social Impact of Computers

Purpose

The unit is designed to raise awareness and develop understanding of computers, with emphasis on how computers operate, who uses them, and on the effects this technology will have in the home, at work, and in education.

Required Background

None.

Key Ideas

- Computers are extremely fast and efficient at calculations and problem solving.

- Computers can handle a tremendous amount of information in a variety of ways that would take a person years to accomplish.

- Computers can only do what they are programmed to do.

- As computers become more common in the home, at work and in education, they will provide people with access to increasing amounts of information.

- Computers will have a significant impact on our privacy and it may be necessary for society to establish safeguards over this function.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
1. Examine and discuss the ways in which computers affect various aspects of everyday life, and have broad implications for society.	- Discuss or debate topics such as: o ways in which computers affect our lives; o employment opportunities for those with computer skills; o common uses of computers; o legal and social implications of information files on people available to Government and business agencies across Canada; o any others that might be suggested by the class.
2. Identify parts of a computer system.	- Do a 'show and tell' demonstration, preferably with an actual microcomputer and large graphic illustrations.
3. Explain in simple terms how a computer system operates.	- Perform a variety of simple exercises such as those detailed in the Usborne Guide.
4. Identify specific uses for computers.	- Identify dull, routine tasks, and analyse how they might be better handled by a computer.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
5. Demonstrate knowledge of computer terminology	- Relate computer terms and their meanings to comparable aspects of the human memory process. Thus, ROM (Read Only Memory) could be related to a person's ability to store information such as the arithmetic "times table" over a long period of time, and to access that information when solving a problem in mathematics.
6. Understand the strategies and necessary logic for developing a computer program.	- One group of students write out a detailed sequence of instructions for a simple common task such as "putting on a coat" or "tying shoelaces". Other groups do exactly what is written. Problems and difficulties that arise should give some insights into the care needed to write a program for a computer. - Do some simple flowcharting exercises using the standard computer flowcharting symbols.

LEARNING OBJECTIVES	LEARNING ACTIVITIES

The following learning objectives can only be accomplished if the students have access to a microcomputer. Reference is made to software available for use with the Apple Computer. However, nearly all microcomputers have introductory modules that will serve the same purpose.

7. Develop keyboard skills and understand how the keys control different functions.	- Any microcomputer with demonstration disks e.g. Apple II has such a demonstration disk.
8 Run some simple programs on a computer using BASIC programming language.	- Introductory word processing software is available for many microcomputers. E.g. Apple Screenwriter, Applewriter II, Magic Window.
9. Write and execute a simple program using BASIC programming language.	- Study an example of a simple program. The instructional resources for this unit include many suitable examples and exercises.
10. Demonstrate ability to use specific applications such as word processing.	

Instructors unfamiliar with computer hardware may team up with a computing science instructor or microcomputer operator to assist in setting up practical activities.

Resources

Learning Materials

Smith, Brian Reffin. Usborne Guide to Computers. Burlington, Ontario: Hayes Publishing, 1981.

This is an excellent workbook for students and instructors laid out in a colourful, easy-to-understand format. The exercises are especially helpful in simplifying difficult concepts in mathematics and programming.

Textbooks

Dominiak, S., N. Turner and P. Furdek. Microcomputer Orientation Manual: An Introduction to the Apple Microcomputer for ABE Instructors. Powell River: Malaspina College, 1981.

This is a brief overview for the uninitiated of the Apple, its operation and its uses.

Furdek, Patricia. Microcomputer Courseware: Review of Software Suitable for Use in Adult Basic Education. Nanaimo, B.C.: Malaspina College, 1982.

This is a good review of a limited range of software. It may provide a starting point for deciding on software acquisition. Caution is suggested as there are several hundred software publishers and only six publishers are reviewed in this resource book.

Muir, Walter. Computer Awareness: An Introduction For Teachers. Victoria, B.C.: Learning Assessment Branch and Curriculum Development Branch, Ministry of Education, 1983.

This is a good overview of the elements of computer literacy in education. It is excellent background reading for instructors.

Poirot, James L. Microcomputer Systems and Apple BASIC. Austin, Texas: Sterling Swift, 1980.

The first two chapters give a concise historical overview of the development of computers and the main components of a computer system. The last two chapters handle concepts of flowcharting and BASIC programming.

Rothman, Stanley, and Charles Mossman. Computers and Society. Chicago: Science Research Associates, 1976.

A standard textbook that covers many controversial issues related to this technology. There is specific emphasis on the impact on society and on the whole aspect of "control" by computer. Exercises at the end of each chapter provide discussion material for instructor and student.

Tilley, Peggy. The Apple Microcomputer - an Introduction. Powell River, B.C.: Malaspina College, 1982.

A simple, clear workbook for the novice instructor using Apple computers. It covers the range of introductory level programming concepts, including many exercises.

Videotape

Now the Chips are Down

Excellent video which traces the development of the micro-chip industry in California and its impact on technology. Excellent examples and discussions on current and future effects on employment.

Software for "Hands-On" Application

Software acquisition will be determined by the available local access to computing hardware. It is strongly recommended that instructors work closely with colleges or school districts in their area who have access to computers to provide practical, "hands-on" experience for students.

The following publishers offer a wide range of computer software suitable for an ABE computer literacy unit. Because of the volume of material available, the instructor should seek guidance from knowledgeable computer specialists in the institution and the community. Whenever possible, the instructor should obtain a review of any new material intended for purchase and use.

Bell and Howell. Courseware Catalogue (see particularly RMI Computer Literacy Series).

Prentice-Hall. Introduction to Microcomputers (Filmstrip/Slides)
Getting to Know the Micros (Filmstrip/Slides)

Periodical Articles

Angier, Natalie. "The Electronic Guinea Pig." Discover, 4, No. 9 (September 1983), 76.

Schechter, Bruce. "The Speed of the New Machines." Discover, 4, No. 1 (January 1983), 32.

PROPERTIES OF MATERIALS AND ATOMIC STRUCTURE

Topics

Bonds and Atoms: Strength, Denisty, Phase
Vibration of Atoms: Temperature
Electron Structure of Atoms: Colour and Electricity
Interaction of Electrons: Chemistry
Interaction of Nuclei: Fission and Fusion

Purpose

The unit features a simple model of atomic structure and ways to relate this model to basic properties of materials. Study of this unit should be considered prerequisite to the intermediate units in physics or chemistry (except Soil Chemistry).

Required Background

None.

Key Ideas

- Any substance may be described in terms of its physical and chemical properties.
- Physical and chemical properties are based on the atomic structure of a substance.
- A simple model of atomic structure includes a nucleus, a bonding structure, an electron structure, and photons.
- Rules governing the operation of the atomic structure provide a basis for understanding the properties of materials and the variations in these properties among different materials.

LEARNING OBJECTIVES

1. Describe finely divided matter as having a nucleus and a bonding part.
2. Describe the mucleus as having all the mass and the bonding part as having the potential to join the bonding parts of other atoms.
3. Describe solids, liquids and gases, using the atomic model.
4. List the major variations in bonds between atoms such as length, strength, stiffness and regularity.
5. Relate density, hardness or softness, strength or weakness to these bonding properties.
6. Explain that crystals demonstrate extremely regular bonding, and that in different directions the bonds may have different characteristics.

LEARNING ACTIVITIES

- Characterize a number of objects as solid, gas or liquid; hard or soft; strong or weak; dense or light. These objects could inlude Silly Putty, soil or gelatin.
- Relate these properties to the way the objects are used.
- Construct ball and spring models of solids.
- Make various crystals and examine them with a hard lens.
- Determine the various crystal shapes of carbon.
- Investigate the manufacture of faceted gemstones.
- Study a forced air heating system to determine conduction and convection processes.
- List several conductors and insulators, identifying their physical properties.
- Determine a way to compare the cost effectiveness for different types of insulation.
- Examine continuous and discrete emission spectra with a diffraction grating.

LEARNING OBJECTIVES

7. Describe temperature as a measure of the vibration of the atomic parts.

8. Describe convection as warm material moving, and conduction as propagation of atomic vibrations.

9. Explain how the rate of conduction may vary between materials.

10. Relate thermal conduction and thermal insulation to this variation.

11. Identify atomic vibration as affecting bond characteristics such as length and strength.

12. Relate thermal expansion and phase changes to this effect.

13. Integrate electron structure and photons as third and fourth parts of the atomic model.

14. Recognize the production and absorption of light, including infrared or radiant "heat" transfer, as a reorganization of the atomic electron structure.

LEARNING ACTIVITIES

- Examine different coloured objects in different coloured light.

- Construct white light with overlapping primary coloured light and then repeat the experiment using paint.

- Do library research on how fireflies produce light.

- Construct a conduction meter with a meter, battery and protection resistor and measure electrical conductivity of different materials including solutions.

- Perform experiments in static electricity, using glass rods, nylon combs, tissue paper, silk, etc.

- Construct and operate a simple electroplating cell.

- Do library research into electric storms, static cling, electric eels, and grain elevator fires started by static electricity.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
15. Describe colour as a sense and also as a surface property of solid materials.	- Carry out several simple chemical experiments such as adding baking soda to vinegar, heating sugar, and heating egg whites.
16. Define conductors and insulators in terms of electron structures.	- Draw diagrams of various simple atoms and compounds.
17. Explain static electrical phenomena.	- Compare fission and fusion.
18. Define an electric current as an organized flow of charges.	- Do library research on military and non-military uses of atomic reactions, and the safeguards needed for these applications.
19. Define Chemistry as the study of the interactions between the bonding parts of different atoms.	
20. Give several examples of common chemical reactions.	
21. Define elements and compounds in terms of the atomic model.	
22. Define nuclear fission and fusion and state several examples of these reactions.	

Resources

Andrews, William A., and others. Discovering Physical Science. Scarborough, Ont.: Prentice-Hall Canada, 1982, Chapter 24.

Bolton, W. Patterns in Physics. New York: McGraw-Hill, 1974, Unit 10.

Harris, N.C., and E.M. Hemmerling. Introductory Applied Physics. New York: McGraw-Hill, 1972, Chapters 25 and 26.

Heath, Robert W. and others. Fundamentals of Physics. Toronto: Heath Canada, 1978, Chapters 11 and 12.

SCIENCE AND TECHNOLOGY

Topics

Technology, Science and Society
Simple and Complex Technologies
Careers Related to Science

Purpose

This unit could be effective as the concluding unit of a course. It provides an opportunity to summarize and integrate knowledge gained from a number of intermediate or advanced units. A central theme is how science and technology affect almost every aspect of modern life. Through other units in the course, students will have built up a knowledge base of facts, concepts and process skills useful for future learning and thinking. The unit focuses on the application of this background to an appreciation of the value and limitations of science and technology in society.

Required Background

Completion of several intermediate science units, and the ability to: use science concepts, process skills and values in making responsible everyday decisions; distinguish between scientific evidence and personal opinion; understand that the development of scientific knowledge depends upon the process of inquiry and the testing of theories; understand that scientific knowledge is tentative and is subject to change as new evidence arises.

Key Ideas

- An increasing number of individual and societal problems which have an impact on the quality of life are related to science and technology.

- Technology is the use of science for practical purposes. Science and technology depend upon each other and can help improve the quality of life, the environment or aid in the conservation of natural resources.

- Not only do science and technology influence society, but society also influences science and technology.

- Industry employs engineers, scientists, technologists, skilled tradesmen and production workers, all of whom require a basic science education.

LEARNING OBJECTIVES

1. Explain how science and technology are related and recognize the limitations as well as the usefulness of science and technology in advancing human welfare.
2. Understand the applications of technology and the decisions entailed in the use of technology.
3. Appreciate, from one's own knowledge and experience, the value of research and technological development.
4. Explain how science and technology may be seen as a threat to society and discuss ways in which social and technological goals may be reconciled.
5. Appreciate science and technology for the intellectual stimulus they provide.
6. State reliable sources of scientific and technological information and use these sources in the process of decision making.
7. List and describe several careers related to science.

LEARNING ACTIVITIES

- List examples of science and technology observed on television. Many programs (and commercials) depict some area of science. Often an entire program is devoted to a particular technical aspect or breakthrough of science and its effect on daily life.
- Investigate how science and technology are helping to improve the environment and assist in conservation in some of the following areas:
  - o disposal of radioactive wastes from nuclear power plants;
  - o decreases in pollution from automobiles and industry;
  - o biological control of harmful insects, scientific management of forests, development and use of improved fertilizers;
  - o development of alternate sources of energy.
- Investigate allegations that science and technology are a threat and detriment to society.

ADDITIONAL ACTIVITIES

- List ways in which technology is a benefit to the worker or citizen and ways in which it is not. Discuss these reults.

- Investigate a local or regional science-related issue. Determine the benefits and limitations of science and technology, and their eventual impact on society and the environment.

- Investigate some important contributions made by Canadian scientists and engineers to the fields of science and technology. Discuss the domestic as well as the international significance of these new technologies, e.g. advances in Telidon computer technology, or the arm for the NASA space shuttle.

- Research some scientific tools which have helped scientists to learn more about their surroundings (e.g. lasers, space satellites, electron microscopes, CAT scanners, computers). Discuss how these tools can be used to improve Canadian society (e.g. satellite communications, meteorological forecasting that employs computer technology, precautions against oil spills in the Arctic or Pacific oceans).

- Investigate new developments in biotechnology and discuss the impact of this new field on medicine, forestry, agriculture, the food industry and bioengineering. Examine the difficulty of making decisions based on scientific data but relating to social morality.

- Contact scientists at nearby universities, colleges, hospitals, government agencies, industries or research stations. Arrange for them to visit the class or be interviewed to determine why they chose science as a career, what kind of work is required, and what makes the work rewarding.

Resources

Periodicals

Local Newspaper
Discover
Equinox
National Geographic
Science Digest
Science Dimension
Science Teacher
SciQuest

Discussion Papers

George, Donald A. An Engineer's View of Science Education. Ottawa: Science Council of Canada, 1981 (free).

National Science Teachers Association (U.S.). Science - Technology - Society: Science Education for the 1980s. Washington, D.C.: NSTA, 1982 (free).

Page, James E. A Canadian Context for Science Education. Ottawa: Science Council of Canada, 1979 (free).

Risi, Marcel. Macroscole: A Holistic Approach to Science Teaching. Ottawa: Science Council of Canada, 1982 (free).

Roberts, Douglas A. Scientific Literacy: Towards Balance in Setting Goals for School Science Programs. Ottawa: Science Council of Canada, 1982 (free).

Thomas, Lewis. "On science and 'science'." Discover, 3, No. 8, (August 1982) 69.

ABE

DEFINITION, EXPLANATION, AND INDEX OF UNITS

Definition

Intermediate units are those that require little or no previous science background and are divided into General, Biology, Chemistry, and Physics groups.

Explanation

Each sample unit contains information listed under these headings:

Topics,
Purpose (of the unit),
Required Background,
Key Ideas,
Sample Learning Objectives,
Learning Activities,
Resources.

Instructors should note that the number of activities related to one objective may vary. Neither the substance nor the order of the activities should be considered prescriptive; rather, instructors are encouraged to determine the selection and organization of activities according to the goals of the learners.

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GENERAL SCIENCE

CONSUMER CHEMISTRY

Topics

Chemistry of Fabrics
Chemistry of Cosmetics and Drugs
Chemistry in the Garden
Chemistry in the Workshop

Purpose

The purpose of this unit is to explain the chemistry of everyday life in terms which a person without any formal knowledge of chemistry can understand.

Required Background

None.

Key Ideas

- Chemical substances react together according to predetermined patterns.

- One can predict the outcomes of such reactions and make practical use of this knowledge.

LEARNING OBJECTIVES

Chemistry of Fabrics

1. Classify fabrics as natural or synthetic and by their chemical makeup as proteins, cellulose, acetate, etc.
2. List desirable characteristics of each of the above groups of fabrics, as well as problems encountered in their use.
3. Define terms such as blend, yarn-dyed, crimp-set, bonded, perma-press etc. Explain the basic process involved and the resulting effect on the textile.
4. Distinguish direct, vat and ingrain dyeing, giving examples of the use of each.
5. Define mordant and give two or three examples.
6. Explain the bleaching action of chlorine and peroxy bleaches.
7. Define the terms flame proof, flame resistant and fire retardant. Describe the process used in each.
8. List the three basic kinds of stains and give examples of each and the basic methods for removing each.

LEARNING ACTIVITIES

- Collect fabric samples and lebel as to content, use, method of cleaning, etc.
- Collect fabric description from advertisements etc. and explain terms used in them.
- Test the effect of boiling water, acid, alkalie, alcohol and acetone on fabric samples.
- Experiment with natural dyeing using onion skins, beets, cedar bark etc. with natural wool or unbleached cotton.
- Find the effects of a mordant on natural dyes.
- Try the effect of chlorine and peroxy bleaches of white and coloured fabrics made of various fibres.
- Test the flammability of fabrics both treated and untreated fabrics.
- Try to remove various stains.
- Visit a dry cleaner and find out what solvents are used for general cleaning and stain removal.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
9. List solvents used in drycleaning. Explain how dry cleaning and laundering differ. Give examples of fabrics which must or must not be dry-cleaned.	
Chemistry of Cosmetics and Drugs	
1. Be familiar with government regulations re chemicals in cosmetics.	- Report on the testing of cosmetics or on dangerous substances.
2. List basic ingredients in various types of cosmetics (e.g. face powder, rouge, lipstick, mascara, nail polish etc.).	- Ask a cosmetologist to speak to the group or interview one to find out what training and duties this work involves.
3. List major ingredients in personal use items such as toothpaste, mouthwash, deodorants, shampoo etc. Which are major active ingredients and which are added to increase the appeal of the item.	- Make toothpaste or mouthwash. - Debate the fluoridation of drinking water. - Make posters about safe storage of poisons in the home.
4. Describe the criteria set in advertising items such as toothpaste.	
5. Explain why sodium fluoride is added to tooth paste or drinking water.	
6. List the active ingredient in over the counter remedies such as aspirin, milk or magnesia, epsom salts, kaopectate etc.	
7. List emergency treatment for aspirin over-dose and ingestion of poisons such as acids, solvents, etc.	

LEARNING OBJECTIVES	LEARNING ACTIVITIES
Chemistry in the Kitchen and Laundry	
1. List a number of leavening agents and explain how each works.	- Compare the gas production by different leavening agents.
2. Describe a protein molecule in general terms. Explain what happens when it is heated.	- Test the effect of heating egg albumen to various temperatures from 70-110°C.
3. Describe a starch molecule. Explain what happens when it is heated.	- Use a slow cooker to show the effect of heating popping corn to 250°, 300° and 350°F. Compare the length of time for the first kernel to pop and the percentage popped in a given time.
4. List the products formed in the caramelization of sugar.	
5. List other sweetening substances used in food products, stating the natural sugar(s) present in each.	- Compare the pH of sugar solution and caramel solution. - Make soap from lye and animal fat. (Instructions are on the lye tin).
6. List several synthetic sweetners which may be used in Canada. Explain why others, such as saccharin, are banned.	- Collect soap samples (hand, powdered, liquid, laundry, etc). Compare the pH, suds production and effect on an oil-water mixture.
7. Describe the process used to make soap. List factors which determine the nature of the product.	- Do the above with various synthetic detergents.
8. Explain the differences in content and use between "built" and "unbuilt" soaps.	- Collect samples of various household cleaners. Classify by active ingredients. Determine the pH of each.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
9. Explain how synthetic detergents differ from soaps, and what is meant by "built" and "unbuilt" detergents.	- Make 5% solutions of ammonia, tri-sodium phosphate and sodium carbonate. Compare pH and effect on an oil-water mixture.
10. Describe the cleaning action of soap.	- Dissolve powdered cleaners in hot water and allow to settle. Compare the amount of undissolved material. Examine a sample of this material microscopically.
11. Give the active ingredient of ammonia-based cleaners and describe its cleaning action. Explain why ammonia and bleach should not be mixed.	
12. Explain the clearning action of tri-sodium phosphate and sodium carbonate and 1why solutions of these cleaners feel "soapy".	
13. List the abrasives used in cleaning powders as well as other active cleaning ingredients in them.	
14. Name several chemicals which are active ingredients in specialized cleaners such as oven and drain cleaners, silver polishes etc.	
Chemistry in the Garden	
1. List the 3 major ingredients in fertilizers and relate to the numbers on fertilizer packages.	- Examine fertilizer containers. Report on regulations on their labelling.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
2. Give fertilizer formulations suitable for lawns, vegetable gardens, houseplants, etc.	- Grow grass in pots and water with different fertilizers. Report on the rate of growth of each.
3. Explain how slow release fertilizers work. Describe forms that these are sold in.	- Place slow-release fertilizer in water and compare N, P, K content of unshaken samples after 1, 6, 24 etc. hrs. Use a commercial soil test kit to determine these. Compare with other fertilizers.
4. List several lime products used on gardens, giving the common and chemical names of each. Explain why lime is used.	
5. List several insecticides used in gardens and in the home. State the insect pests each is used for. (Or reverse, state pest and appropriate insecticide).	- Collect several insecticide labels, listing active ingredient, mode of use and target insect. - Make posters promoting safety with garden chemicals.
6. List precautions to use in storing pesticides.	- List commonly used pesticides and herbicides and compare the toxicity of each to human beings.
7. List methods other than chemical insecticides that can be used to get rid of garden or household pests.	
8. Give the active ingredients in lawn weed killers (such as weed-n-feed), brush killers, etc.	

LEARNING OBJECTIVES

Chemistry in the Workshop

1. List the bases used in glues and adhesives such as acitate, resin, casein, silicate etc. and the use each is suitable for.

2. List solvents for each of the bases listed in #1.

3. List the 3 main types of paints by base ingredient. State which are water-soluble and which are soluble only in solvents such as turpentine.

4. List other substances such as shellac, urethane etc., used as surface finishes. Tell what each is made from and a suitable solvent for each.

5. Describe the mode of action of paint removers, listing chemicals forming the active ingredient(s).

6. Lit materials used to treat fence posts etc. to prevent rotting. List the chemicals used. Tell how these substances prevent or slow down rotting of wood.

7. List common solvents by their commercial and chemical names. State which are flammable and which have poisonous fumes.

LEARNING ACTIVITIES

- Collect glue labels and packages. Classify by use, basic ingredient or solubiity in various solvents.

- Mix small amounts of various paints with water and with turpentine or other solvent. (Small spice bottles are excellent disposable "test tubes").

- Repeat the above with other finishes such as shellac, shingle stain, polyurethane etc.

- Report on special finishes, such as "textured" ceiling paints, sealers etc., listing chemical compounds used to create the special properties of the finsih.

- Visit and report on a paint factory, fence-post treatment plant or similar business.

- Make posters on safe use and storage of solvents.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
8. List precautions to be taken in using solvents, and steps to take if a solvent is spilt, accidentally swallowed or splashed on the face.	
9. Explain how spontaneous combustion occurs with oily rags, paper, etc.	

Resources

Books

Corbman, Bernard P. *Textiles: Fiber to Fabric*. Scarborough, Ontario: McGraw-Hill Ryerson (Canadian Metric Edition), 1975.

Kleeberg, Irene C. (Ed.). *The Butterick Fabric Handbook*. New York, N.Y.: Butterick, 1975.

Moore, Alma C. *How to Clean Everything*. New York: Simon and Schuster, 1978.

Taylor, J. (Ed.). *Science at Work* (Series). Menlo, Calif.: Addison-Wesley, 1979. (This British series includes modules with titles such as "Fibres and Fabrics", "Cosmetics", "Dyes and Dyeing", "Forensic Science", "Foods and Microbes".)

Winter, R. *A Consumer's Dictionary of Cosmetic Ingredients*. New York: Crown, 1976.

Pamphlets (free)

Consumer and Corporate Affairs Canada.
Look at That Label!

Ontario Ministry of Agriculture and Food.
How to Remove Stains.

DRUGS AND THEIR USE

Topics

Prescription, Non-Prescription and 'Street' Drugs

Purpose

To consumers, parents and citizens a knowledge of both the beneficial and harmful uses of drugs is of particular value. The unit deals with possible interaction of drugs with one another and with alcohol, the effects of accidental or purposeful over-dosage and the dangers of using drugs of questionable origin or purity.

Required Background

A basic knowledge of the metric system and human anatomy.

Key Ideas

- Prescription and non-prescription drugs exert beneficial effects when properly used. Improper or excessive use can be extremely harmful.
- Serious side-effects can result from drug interactions.
- Alcohol is a drug and interacts with many non-prescription and prescription drugs.
- The use of tobacco is habit-forming, and exposes the body to a number of harmful chemicals.
- "Street" drugs are prepared under uncontrolled conditions, may vary in strength and be contaminated by other chemicals.
- Repeated use of any drug may result in a decline in its effectiveness, a need for increased dosage, allergic or other reactions, physical dependence, or addiction.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
1. List types of drugs according to use: analgesics or pain relievers, digestive aids, antibiotics, antihistamines, tonics, respiratory medicines, local (external) remedies, etc. and give a common example of each. Recognize the purpose of drug forms: tablets, capsules, liquids, pastes, ointments, etc.	- Collect empty prescription and non-prescription drug containers, external wrappings and accompanying instructions. - Read labels etc. and prepare a list of common drug use terms and their meanings. - Be able to convert common metric amounts in millilitres into household measurements of teaspoons, etc.
2. Explain the meaning of various dosages and instructions for use.	- Prepare lists of ingredients in several different headache remedies, cold and cough medicines, muscular rubs, etc.
3. Explain the effect on the body of common non-prescription drug ingredients such as salicylic acid, phenacetin, etc. 4. Discuss the importance of following doctor's orders and label information for prescription drugs.	- Invite a pharmacist or other knowledgeable person to discuss prescription instructions, the differences between prescription and non-prescription drugs, and drug safety in the home.
5. List safety precautions for drug use and storage especially with regards to children and baby-sitters. Explain the reasons for discarding left-over drugs.	- Read a 'pharmacopoeia'. - Prepare stickers with emergency telephone numbers for drug and poison ingestion. - Read about Medic-Alert and other registration schemes for persons with medical problems.

LEARNING OBJECTIVES

6. Tell what to do if a child or other person takes an overdose of any drug, or one not intended for their use (including birth control pills).

7. List symptoms of overdose, allergic reactions to antibiotics and other adverse reactions to drugs.

8. Explain the difference between medically required continual use and drug overuse.

9. Describe ways in which the body reacts to continued use of substances such as aspirin and other pain relievers, tranquilizers, sleeping pills, etc.

10. Discuss drugs which are stimulants or depressants and their effect on the body.

11. Examine the use of alcohol as a stimulant and as a depressant. Explain its interaction with other drugs such as antihistamines, cold remedies, tranquilizers, sleeping pills and stimulants ("pep" pills).

12. List the symptoms of alcohol abuse, current theories of the cause of alcoholism and methods for its treatment.

LEARNING ACTIVITIES

- List common conditions such as diabetes, heart disease, epilepsy, etc. which require continual medication.
- List questions to ask your doctor about prescriptions given to you or another member of your family.
- List medical and popular names of common stimulants and depressants, their proper use and results of abuse.
- Invite a speaker or show a film on alcoholism, its treatment, social effects and possible causes.
- Invite the RCMP or other such organization to speak on alcohol and driving, and/or illicit drugs.
- Use various sources to find statistics relating to use of tobacco to respiratory and coronary disease and other health problems.
- Organize a debate on the pro's and con's of tobacco use.
- Sponsor a quit smoking clinic in your program, school or community.
- Write a report on a harmful drug substance.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
13. List the active chemical ingredients found in tobacco products and explain their effects on the human body. 14. Discuss the relationship between the use of tobacco and the occurrence of respiratory and coronary diseases. 15. List the source, short and long-term effects, symptoms of use of illicit drugs such as marijuana, heroin, cocaine, LSD, PCP, etc. 16. Discuss the social implications of drug abuse, such as effect on physical and mental ability, employment, criminal activity, etc. 17. Discuss current theories of the causes of drug addiction and treatment of addicts. 18. List the arguments for and against the legalization of presently illicit drugs, or the registration of drug addicts. NOTE: Students also studying the unit on Disease should be able to discuss the dangers of self-doctoring and the use of home remedies of questionable effect.	- Make posters about any of the topics studied in this unit. - Write a report on the discovery of a beneficial drug such as insulin or penicillin. - Collect magazine and newspaper articles, pamphlets, etc. dealing with the problems of illegal drug use. - Write a report on the social implications of an illegal drug or of illegal drugs in general. - List a number of common "home remedies", herbal medicines, etc., try to find out the active ingredient, if any, in each preparation.

Resources

Texts

Heimler. Focus on Life Science: 333-342.

Heimler and Neal. Principles of Science: Book 2: 140-159.

Other Books

Benowicz, Robert J. Non-Prescription Drugs and Their Side Effects. New York: Berkley, 1982.

Canadian Pharmaceutical Association. Compendium of Pharmaceuticals and Specialties. Ottawa: CPA, 1982.

Conant, Roger. Drugs: Facts for Decisions. Syracuse, N.Y.: New Readers' Press, 1976.

Day, Nancy Raines. Tobacco: Facts for Decisions. Syracuse, N.Y.: New Readers' Press. 1978.

Lichtman, Gail. Alcohol: Facts for Decisions. Syracuse, N.Y.: New Readers' Press. 1974.

Long, J.W. The Essential Guide to Prescription Drugs. New York: Harper and Row, 1982.

Pamphlets (free)

British Columbia. Ministry of Health: Alcohol and Drug Commission. Pamphlets available on tobacco and nicotine, psychedelics, barbiturates, amphetamines, etc.

Canada. Health and Welfare.
Over-the-Counter Remedies (series of 4)
Women, Smoking and the Pill
You, the (Hurrah!) Ex-smoker and Food

Pharmaceutical Manufacturers' Association of Canada: Medicine Your Doctor Prescribes

U.S. Department of Health, Education and Welfare.
Food and Drug Interactions (HEW 76-3070)
Mixing Medicines? Have Care (HEW 76-3020)
Painkillers: Their Uses and Dangers (HEW 70-3060)
Primer on Medicines (HEW 74-3014)
Tranquilizers: Use, Abuse and Dependency (HEW 79-3084)
We Want You to Know About Prescription Drugs (HEW 78-3059)

Films

An Easy Pill to Swallow (tranquilizers)
29:32 106C 0178 341

Alcohol: How Much is to Much?
10:57 106C 0176 098

EARTH SCIENCE

Topics

Properties of Rocks and Minerals
Changes in the Earth's Surface
Earth History

Purpose

The unit provides an introduction to the composition, classification and properties of rocks and minerals; geological formations, and the detection and interpretation of earth movements. Some insights can be gained into the methods used by geologists to "read" and interpret the earth's past.

Required Background

None.

Key Ideas

- Rocks can be classified according to their mode of formation.

- All rocks are composed of minerals that can be easily identified by their physical and chemical properties.

- Earth's crust is constantly changing and moving because of internal and external forces.

- Geological forces of today are believed to be the same as those of the past, but may not always be operating at the same rate.

- The geologic history of the Earth has been divided into major eras corresponding to geological revolutions which produced widespread changes.

LEARNING OBJECTIVES

1. Define geology as the scientific study of the structure, formation and history of the earth.
2. Draw and label a cross-sectional diagram of the earth's interior.
3. Demonstrate a knowledge of earth materials and the rock cycle.
4. Demonstrate a knowledge of igneous intrusion and extrusion.
5. List the characteristics that are useful in the recognition and identification of minerals.
6. Describe the types and effects of weathering, erosion and deposition.
7. Explain that the hardness of rock determines the rate at which it is worn away.
8. Explain the effects of rock movements which continually occur in the earth's crust.
9. Demonstrate a knowledge of the evidence leading to the plate tectonic theory.
10. Explain how movement of the earth's plates cause earthquakes and changes in the earth's surface.

LEARNING ACTIVITIES

- Bring rock samples or collections to present and explain to the class.
- Classify rocks based on their similarities and differences of physical and chemical properties e.g. colour, texture, size of grains, streak, luster.
- Find examples of extrusive igneous rock (basalt) or intrusive igneous rock (granite).
- Invite a guest speaker on mining or prospecting.
- Visit a local mine site, concentrator or smelter.
- Study local landforms to determine the effects of weathering and erosion.
- Collect data on the nearest active fault zone.
- Design experiments to investigate the pressures exerted during mountain building e.g. with dominoes, building blocks, metre sticks, etc.
- Visit local volcanic landforms, hotsprings, lava beds.
- Predict volcano and earthquake zones based on historical data and an understanding of plate tectonics.

LEARNING OBJECTIVES

11. Describe the nature of earthquakes and volcanoes.
12. Explain how seismographs are used to pinpoint the location of earthquakes and to investigate their properties.
13. Explain that the geologic forces of today are the same as those of the past (the law of uniform change).
14. Explain how data are gathered and inferences are made about extinct species of life.
15. Understand why older fossils in lower rock strata are less complex than the younger ones in higher strata.
16. Explain how the age of some rocks may be determined by radioactive dating.
17. Explain how the geologic revolutions which separate eras are marked by changes in plants, animals, landscape and climate.
18. Appreciate that the earth's surface is in transition.

LEARNING ACTIVITIES

- Investigate various earthquake reporting scales.
- Relate the South Pacific archipelagos and "oases of life" to plate tectonics.
- Create P and S waves with a "slinky" and discuss compressional and transverse waves in general.
- Determine earthquake epicentres from the differences between P and S wave arrival times.
- Observe collected or simulated fossils.
- Explore reasons for the rapid extinction of dinosaurs.
- Visit a local fossil site.
- Interpret the method by which a fossil was formed.
- Relate biological diversity to the geological time scale.
- Compare carbon, potassium-argon and uranium-lead absolute dating procedures.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
19. Integrate the characteristics of faults, folds, earthquakes, and volcanoes into the model of plate tectonics.	- Plot the positions of volcanoes and past earthquakes on a map of the earth and develop theories regarding the occurrence of these factors.
20. Assess the potential value of earthquake prediction to society.	- Construct a cinder cone model.
21. Appreciate the continual process of change on the earth and its effects on living species.	- Research why scientists study the interior of the earth.
22. Appreciate human existence in terms of the geologic time scale.	- Participate in a field trip of the local area to study the diversity of plants and animals.

Resources

Texts

Bishop, Sutherland and Lewis. Focus on Earth Science. Unit Two, Chapters 2, 3 and 4. Unit Four, Chapters 1, 2, 3 and 4

Heimler and Neal. Principles of Science: Book 1. Unit Three, Chapters 1 and 2.

Films

The Meteor and the Dinosaur. Nova Series, P.B.S.

Riches of the Earth. N.F.B. #0166 019. This film depicts (in colourful animation) the formation through geological ages by fire, water, wind and ice of the earth's crust which holds our wealth of minerals, oil, coal, arable land and water power.

Periodical Articles

Angier, Natalie. "Time Machines in the Sea." Discover, 3, No. 8 (August 1982), 51.

A biologist has found marine creatures thought to have been extinct for millions of years.

Davis, M. "Dropping Out in Florida." Discover, 2, No. 7 (July 1981), 22. Ancient limestone and a new drought combine to create a landscape of sinkholes.

Gorman, J. "First of the Red Hot Mamas." Discover, 2, No. 10 (October 1981), 90. New fossil finds suggest some dinosaurs may have been warmblooded.

Overbye, D. "Waiting for the Volcano." Discover, 3, No. 10 (October 1982), 18. Rumblings under a California resort may mean that an ancient volcano is ready to erupt again.

________. "The Shape of Tomorrow" Discover, 3, No. 11 (November 1982), 20.

A geologist plots the movement of continents in order to predict the future shape of the world.

"Bad Vibrations in the Golden State." *Discover*, 2, No. 12 (December 1981), 90. Some ominous happenings along the San Andreas Fault stir new fears of a big West Coast earthquake.

Other Resources

Regional geological maps, and sample sets of common rocks and minerals available from the Geological Survey of Canada.

ECOLOGY

Topics

Principles of Ecology
Food Chains and Webs
Limits to Population Growth

Purpose

Since living organisms rarely exist by themselves, it is essential to learn about the inter-relationships between organisms and their living and non-living surroundings. One important aspect of such a study is the food-energy transfer seen in food chains and webs. It is also important to understand the factors which limit the size and extent of biological populations. This unit is suitable for students who plan to study other units about the environment.

Required Background

A general knowledge of common plants and animals, where they live, what they eat, and of the process of photosynthesis.

Key Ideas

- Every living organism interacts with other organisms, and with its physical and chemical environment.

- Most living organisms need energy in order to exist and acquire this energy directly or indirectly from the sun.

- The biological, chemical and physical properties of the environment act together to set limits on the size and extent of population growth.

LEARNING OBJECTIVES

1. Define ecology and environment.
2. List several biological, chemical and physical properties of the human environment and that of several diverse types of plants and animals.
3. Explain how a change, sudden or gradual, can affect the environment of an organism.
4. Define the terms: biosphere, population, community, habitat, biome and niche, giving examples of each.
5. Describe a simple 3- or 4-step food chain or pyramid, explaining where the energy originates, what happens to it at each level and why.
6. Draw, or label a diagram of the energy cycle.
7. Explain the difference between an autotroph and a heterotroph, giving examples of each.
8. Define the terms: carnivore, herbivore, omnivore, parasite, symbiont and commensal, and give examples of each.

LEARNING ACTIVITIES

- Read introductory books to compile a small glossary of ecological terms, including examples.
- List the properties of the human environment and those of common plants and animals.
- Discuss the effect of seasonal change and sudden change (fire, flood, drought) on plants and animals in the local area.
- Find figures on the relative efficiency of a plant-cow-man diet vs. a plant-man diet.
- Make lists of common local plants and animals and classify each as a heterotroph or an autotroph.
- Use this list and classify the heterotrophs as carnivores, herbivores or omnivores.
- Prepare lists of parasites, symbionts and commensals and specify to which other organisms each relates.
- Prepare posters of various groups of animals such as carnivores, parasites, etc.
- Draw diagrams of several food webs which exist among wild or domestic organisms in the local area.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
9. Show how a number of food chains can intermesh to form a food web and draw a diagram of a food web with a number of members.	- Prepare charts illustrating food chains and webs.
10. Explain what happens to a food chain or web if one member becomes scarce or over abundant.	- Ask a wildlife protection officer or biologist to come and speak on cyclic phenomena in wildlife, the effects of a recent forest fire, or similar topic.
11. Explain how physical or chemical environmental factors can affect a food chain.	- Study the effect of light and pH on jars of algae or bean seedlings.
12. List a number of factors which will affect the size of a population and explain why each has an effect.	- Look up population statistics for Canada, British Columbia, or local area. Determine the relative effects of births, deaths, immigration and emigration.
13. Explain the effect of birth-rate, death-rate, immigration and emigration on a population.	- Report on population changes in deer, moose, or some other wild animal of importance, finding out factors which may have caused changes.
14. List a number of external factors which may affect population growth.	- Write a report on the effect of a predator extermination program (e.g. wolves) and the resultant effect on other wild-life populations.
15. List the factors which limit maximum population size and explain why these factors are not always the same for every population of a particular organism.	- Find out why some animals such as the raccoon have been able to survive in urban areas and why others have not.
16. Explain what happens when a population approaches or reaches its limit. Relate this to a food chain or web.	

LEARNING OBJECTIVES	LEARNING ACTIVITIES
17. Show how the community in an area is not static but undergoes successive changes until it reaches a climax.	- Report on studies of over-population with mice or rats.
18. List factors which may lead to the extinction of a species and explain how threatened extinction may be reversed.	- Write a report or compile a series of photographs showing changes in an area with time after a forest fire.
19. Use one or more techniques to find the size of a given population, and the extent of changes in it.	- Interview long-time local residents who can tell how the vegetation may have changed, such as on a deserted farm or a dried-up swamp.
20. Explain a procedure to determine the species represented in an area.	- Prepare a labelled collection of plants typical of each stage in succession after a fire, cultivation or drying up of a swamp.
	- Find pictures of endangered species and explain what steps, if any, are being taken to prevent the extinction of each.
	- Find out and report on the cause of the extinction of the dodo, passenger pigeon, etc.
	- Use keys, handbooks, etc. to identify various plants and animals (not just mammals) in the local area, using locally accepted common names.

ADDITIONAL ACTIVITIES

- Do a square metre count of organisms.
- Use a counting chamber to determine the algae population (one or more species) in a pond water sample.
- Visit a salmon counting station in the fall.
- Visit or interview an agriculturist or forester studying changes in the insect population, paying special attention to techniques used.
- Study the normal North American human food chain and compare it with that in aboriginal and other societies here and in other parts of the world.
- Start one or more cultures of algae and study the effect of temperature, light or time upon each.
- Plant radish or other small, quickly growing seeds in a small pot and study differences in the resulting plants.

Resources

Texts

Heimler. Focus on Life Science: 444-461.

Heimler and Neal. Principles of Science: Book 1: 388-427.

Other Books

Heintze, Carl. The Biosphere: Earth, Air, Fire and Water. New York: Lodestar, 1977.

Kormondy, Edward J. Concepts of Ecology. Englewood Cliffs, N.J.: Prentice-Hall, 1976.

Pamphlets (free)

Canadian Wildlife Federation. Wildlife in Your Backyard.

National Museum of Sciences, Ottawa. Biome (newsletter).

Films

Nature's Food Chain
13:28 106C 0177 ____

This is an Emergency
28:50 106C 0179 ____

Periodical Article

Levenson, Thomas. "Pacific Life Struggles in a Warming Sea." Discover, 4, No. 10 (October 1983), 28.

Scientists look to El Nino to show how life in the ocean survives through rich and poor years alike.

See also Resources listed for Environmental Control and Waste Management units.

ENVIRONMENTAL CONTROL

Topics

Value of Natural Resources
Conservation Measures
Renewable and Non-Renewable Resources

Purpose

The unit focuses on the major natural resources in Canada and the need for their conservation or replenishment for future generations. A resource of local importance or of particular interest may be studied in depth.

Required Background

The intermediate unit on Ecology provides desirable background.

Key Ideas

- Natural resources of soil, water, forests, wildlife, minerals and petroleum are rapidly being used up.

- People have a responsibility to control the use of resources and to renew them whenever possible in order to assure their future availability.

LEARNING OBJECTIVES

1. List natural resources found on the earth and distinguish between those which are renewable and non-renewable.
2. Define conservation.
3. Describe the methods by which soil is formed and the general types of soil which result.
4. List uses of soil.
5. Explain how soil can be wasted and methods by which this waste can be prevented.
6. List uses of water and identify uses that may result in the deterioration of water quality.
7. Discuss ways of increasing the availability of water and of improving its quality.
8. List a number of uses of forests in addition to being a source of forest products such as lumber and pulp.
9. Explain why fire may have both a good and a bad effect on a forest.
10. Discuss the importance of wildlife as a resource and identify the organisms that are classed as wildlife.

LEARNING ACTIVITIES

- Study land use maps of the world, continents, Canada or British Columbia.
- Look up meanings for conservation in several different reference books.
- Study soil maps for Canada, B.C. and the local area.
- Make posters of soil formation.
- Collect illustrations of soil erosion from various causes.
- Take a field trip to an eroded area or an erosion prevention project. (If studying alone, make sketches or take photographs for a report.)
- Build an erosion model and explain how it works.
- Determine settling rates of different soil types.
- Take soil cores and identify layers.
- Study local water sources and uses.
- Visit a local water chlorination and/or sewage treatment plant.
- Interview (or invite as a speaker) the local official responsible for water standards.

LEARNING OBJECTIVES

11. Discuss the need for hunting and fishing regulations.
12. Become familiar with specific regulations in the local area.
13. List methods of increasing the availability of selected sport mammals and fish.
14. List major non-renewable energy and mineral resources of importance in B.C. and Canada.
15. Discuss world-wide energy needs and how they are being met (or otherwise).
16. Compare ways of conserving gasoline and other energy resources and products.
17. List ways of conserving mineral resources.

LEARNING ACTIVITIES

- Discuss the problems with wells and septic tanks caused by the spread of urbanization toward rural areas.
- Research local industries which use water, methods of use and steps taken to prevent waste.
- Visit a forestry display or information centre.
- View a film on forest fires and their prevention.
- List local industries which are dependent on the forest for their existence.
- Find out how forest use is regulated locally.
- Visit a sawmill or pulp mill.
- Visit a tree nursery.
- Interview a tree planter.
- List plants and animals which are wildlife resources in B.C. or locally.
- Find out regulations concerning the protection of endangered species of plants and animals in B.C.
- Prepare a poster on local game mammals, birds and fish.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
	- Take a CORE (Hunter Safety) course.
	- Visit a trout or salmon hatchery, a game farm, or bird sanctuary.
	- Study maps showing mining areas and petroleum, natural gas and coal fields in Canada and B.C.
	- Read reports on the energy crisis.
	- Write a report or make a poster on how the individual can save fuels such as gasoline and diesel.
	- Read about mining methods and determine which may be wasteful, and which apply good conservation principles.

Resources

Texts

Bishop, Sutherland and Lewis. *Focus on Earth Science*: 242-61, 396-457.

Heimler. *Focus on Life Science*: 466-487.

Heimler and Neal. *Principles of Science*: Book 1: 472-505.
Book 2: 454-479.

Heimler and Price. *Focus on Physical Science*: 474-498.

Periodical Articles

Blomston, Gary. "Coyote." *Science 82* (October 1982), 45-52.

Findlay, R. "Our National Forests: Problems in Paradise." *National Geographic*, 162, No. 3 (September 1982), 306-339.

"Special Report on Energy." *National Geographic* (February 1981).
White, Peter T. "Rain Forests: Nature's Dwindling Treasures". *National Geographic*, 163, No. 1 (January 1983), 2-46.

Pamphlets (free)

Agriculture Canada.
Soil Erosion by Water.
Soil Erosion by Wind.
What You Should Know About Soil.

Environment Canada.
Canada's Eight Forest Regions.
Endangered Canadian Wildlife.
Fisheries Fact Sheets.
Forest Fact Sheets.
Good Water - A Vital Need.
Water - Our Element.
Water - (series of 5 pamphlets).
Who's Who in the Hinterland.

Fisheries and Oceans Canada.

British Columbia Tidal Waters Sport Fishing Guide (annual).
Commercial Fisheries Guide (annual).
Get Hooked on Salmonids.

ENVIRONMENT AND WASTE MANAGEMENT

Topics

Water Pollution
Air Pollution
Solid Waste Problems

Purpose

Almost all human activity produces its peculiar type of waste. We can learn from the past and present what problems these wastes cause and how future problems may be prevented. As individuals we share with industry and government the responsibility to reduce waste and prevent pollution. This unit will be of general interest, especially useful to those planning careers in resource industries or health.

Required Background

Intermediate unit on Ecology. The unit on Environmental Control would also be useful background.

Key Ideas

- The individual and collective activities of human beings produce a wide range of waste materials.
- Many waste substances have a detrimental effect on human life.
- Everyone has a responsibility to reduce the production of wastes and control their disposal.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
A. Water Pollution	
1. Show by graphs, figures, or other means, the relative abundance of fresh water on the earth.	- Use atlas and other reference books to prepare a chart on the relative abundance of fresh water.
2. Draw or label a diagram of the hydrologic cycle.	- Make a chart of the hydrologic cycle.
3. List uses of water and sources available for these uses.	- Make a list of all the different uses of water by an individual over a day or a week, with the approximate amounts used for each purpose.
4. Discuss desalination, especially in terms of economics and energy needs.	- Write a brief report on the use of desalination as a water source.
5. Describe the principal types of lakes.	- Classify local bodies of water as to 'still' or 'running' and local lakes as to type.
6. Draw or label a diagram of a stratified lake and explain its seasonal changes.	- Make a poster showing the seasonal stages in the stratification of a lake.
7. List four basic types of water pollutants and several examples of each.	- List local water pollutants and state which type each is.
8. Discuss the results of nutrient enrichment of a body of water and list several sources of such enrichment.	- Carry out BOD tests on water samples or visit a laboratory where such tests are performed.
9. Explain the term 'biological oxygen demand' (BOD) and its relationship to water pollution.	- Read detergent and cleanser labels and specify which are biodegradable.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
10. Explain the terms 'biodegradable' and 'non-biodegradable' and give examples of pollutants of each type.	- Write a report on chemical water pollution. - Visit a local sewage treatment plant and report on the process used and what is done with the effluent.
11. List several chemical water pollutants and their sources.	- Draw a diagram of a tertiary sewage treatment plant.
12. Describe the primary, secondary and tertiary steps in sewage treatment and the resulting materials after each step.	- Draw a diagram of how a septic tank works. - Find out local regulations for the location and construction of a septic tank.
13. Explain how a septic tank works.	
14. List sources of thermal pollution and explain its effect on a body of water.	- Engage in a debate on the pros and cons of nuclear energy plants which cause thermal pollution. - Make a comparative graph of types and abundance of organisms found in normal and thermally polluted water.
15. Discuss oil slicks, their effect, clean-up and prevention.	- Collect newspaper and magazine articles about oil slicks and their clean-up.
B. Air Pollution	
1. List normal constituents of unpolluted air and their relative abundance.	- Make a circle graph of the constituents of air.
2. Draw or label diagrams of the oxygen, carbon dioxide and nitrogen cycles.	- Prepare posters or other drawings of the oxygen, carbon, and nitrogen cycles.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
3. List major sources of air pollution and the principle pollutants from each source.	- Find out what an "air pollution alert" is in major cities such as Los Angeles or Tokyo.
4. Draw a diagram or explain how a temperature inversion develops and the effect on local atmospheric conditions.	- Make a pollutant chart. - Find illustrations of the results of a temperature inversion.
5. List weather and climate conditions which lead to increased or decreased air pollution.	- Find out what conditions caused Los Angeles to become "Smog City, U.S.A.": investigate the smog threat to any B.C. community.
6. List possible effects of air pollution on human health.	- Write a report on "killer fogs".
7. Explain why the automobile is considered to be a major source of air pollution and list the pollutants which it produces.	- Find out government pollution standards for automobiles. - Find out government regulations for industrial smokestacks.
8. Discuss the "greenhouse effect" and list some results which scientists fear it will create.	- Collect pictures and articles on air pollution. - Prepare a diagram of the "greenhouse effect".
9. Discuss volcanoes as natural sources of pollution.	- Find out the effects of raising the world-wide temperature by 10^{o}C.
10. Define noise pollution and explain how it is measured.	- Report on the immediate and long-term, and local and world-wide effects of a major volcanic eruption.
11. Discuss the effect of noise pollution on human health, how to prevent it and to avoid its detrimental effects.	

LEARNING OBJECTIVES	LEARNING ACTIVITIES
12. Explain the probable causes of "acid rain". 13. Describe the effect of "acid rain" on lakes, soil, vegetation and fish. 14. List several other effects of "acid rain". 15. Explain why the prevention of "acid rain" is such a complex problem.	- Find out what noise bylaws, if any, exist in the local community, and how they are enforced. - Obtain copies of the Workers' Compensation Board regulations on noise. - Borrow a sound level meter and determine noise levels at various locations. - Prepare a map showing possible sources of "acid rain" and areas affected in North America. - Test the pH of lakes in the local area and compare the results with those in areas affected by "acid rain". - Make an illustrated report on "acid rain". - Collect newspaper clippings on "acid rain", especially in international or political news.
C. Solid Waste Problems 1. Define: garbage, solid waste. 2. List the main types of components of garbage. 3. List methods of solid waste disposal including open dumps, sanitary land fills, pulverization, incineration and compaction, giving a brief description and list the advantages and disadvantages of each.	- Write a report on garbage sources. - Find out how local garbage is treated or disposed of. - Find out how other communities of similar size dispose of solid wasts; if possible, find out comparative costs.

LEARNING OBJECTIVES

4. Define leachate and explain why it is a problem in open pits and sanitary landfills.

5. Explain composting and how a compost heap works.

6. List and describe specialized methods for dealing with a single type of waste.

7. Discuss recycling and list uses for recycled paper products, glass, metal and rubber.

8. Explain the advantages of recycling in terms of energy use.

9. List several "problem" wastes such as PCB's and atomic waste and explain the problems associated with the disposal of each.

10. List ways people have tried to dispose of these wastes and explain why each approach has or has not been successful.

LEARNING ACTIVITIES

- Report on leachate pollution.

- Make posters comparing various garbage disposal methods.

- Visit a recycling plant.

- Make posters showing how an individual can reduce solid waste production.

- Prepare and carry out a survey on recycling.

- Write a report on the disposal of PCB's or atomic waste.

- Interview local officials to find out problems with solid waste disposal.

- Investigate recent research on the conversion of some wastes into animal feed.

- In agricultural areas, find out how feed-lots, poultry farms, or canneries dispose of waste.

Resources

Texts

Bishop, Sutherland and Lewis. Focus on Earth Science: 396-415, 433-435.

Heimler. Focus on Life Science: 488-507.

Heimler and Neal. Principles of Science: Book 1: 482-483.
Principles of Science: Book 2: 480-503.

Periodical Articles

Angiers, Natalie. "Super Reach." Discover, 3, No. 2 (February 1983), 83.

Boraiko, Allen A. "The Pesticide Dilemma." National Geographic, 157, No. 2 (February 1980), 145-183.

Canby, Thomas. "Water: Our Most Precious Resource." National Geographic, 158, No. 2 (August 1980), 144-174.

James, Jamie. "Who Will Stop the Acid Rain?" Discover, 4, No. 10 (October 1983), 62.

LaBastille, Anne. "Acid Rain: How Great a Menace?" National Geographic, 160, No. 5 (November 1981), 653-681.

Weaver, Thomas. "The Promise and Peril of Nuclear Energy." National Geographic, 155, No. 4 (April 1979), 459-493.

Pamphlets (free)

Agriculture Canada. Let's Talk About Pesticides.
Pesticides: Their Implications for Agriculture.
Pollution and Agriculture.

Atomic Energy of Canada. Nuclear Fuel Waste.

B.C. Lung Association. The Air We Breathe. British Columbia.
Workers' Compensation Board. Noise Control in B.C.

Canadian Pulp and Paper Association. Waste Paper and What to Do About It.

Energy, Mines and Resources Canada. The Garbage Book.

Environment Canada. *Air Pollution and Your Car.*
Air Quality Trends.
Clean Air Act (Statutes of Canada: Ch. 47).
Consumer Conservation.
Coping With Oil Spills.
Downwind: The Acid Rain Story.
The Hazardous Waste Problem.
Keeping the Ocean Clean.
Water: Cleaning Up Pollution.

Fisheries and Oceans Canada. *Acid Rain.*

Films (all NFB)

Canwell
23:00 106C 0178 021

The Garbage Ouroboros
28:00 Nature of Things 106C 1075 209

One Hand Clapping
10:00 106C 0172 060

Water
15:00 106C 0163 004

For annotations see Part 7: Instructional Resources: Audiovisual.

FITNESS AND HEALTH

Topics

Fitness Programs
Functions of Exercise
Exercise and Health

Purpose

The unit leads students through a study of the essential components of physical fitness, the benefits of exercise, and its effects on body chemistry and physiology. Physical exercise will be discussed in the context of recreation as well as the maintenance and improvement of physical and mental health.

Required Background

None; this unit could be studied in conjunction with the intermediate unit on Food and Nutrition.

Key Ideas

- Physical and mental well-being are directly related to, and dependent on, exercise and good nutrition.
- A personal fitness program should be individually designed and based on principles of balanced development and gradual adaptation to meet realistic goals.

LEARNING OBJECTIVES

1. Define fitness.
2. Distinguish between health-related and performance-related fitness and state the basic components of each.
3. Define flexibility and explain its importance to the general health of the individual.
4. List and give examples of ways in which physical conditioning may aid in injury prevention.
5. Identify the most critical periods in a person's life span for the development of increased numbers of fat cells and explain the general trends in the percentage of lean body mass and the percentage of fat as one ages.
6. Discuss the effect that regular vigorous physical activity has on the incidence of cardiovascular disease.
7. Identify the risk factors for coronary heart disease and list those over which the individual has little control.
8. Define what is meant by cardiac output.

LEARNING ACTIVITIES

- List the functions of exercise.
- Investigate why total body exercise is preferable to localized exercise.
- Choose one flexibility exercise for each major area of the body and use it before and after other forms of exercise.
- Read about or research the relationship between lean body mass and fat as a person ages.
- Investigate how regular vigorous exercise may affect the trend of fat build up.
- Compare statistics for cardiovascular disease and relate this to the individual's degree of physical fitness.
- List the factors which contribute to cardiovascular disease and discuss ways to control them.
- Summarize the ways in which individuals can lower their levels of coronary disease risk factors.

LEARNING OBJECTIVES

9. Explain the effect physical conditioning has on resting, exercising and recovery heart rates.

10. Define blood pressure and describe how it changes during exercise as compared with rest.

11. Explain how an individual's cardiovascular health may be evaluated.

12. Explain the procedures involved in Cooper's 12 minute run test and the scientific basis for it.

13. Explain the effects of vigorous exercise on neuromuscular tension.

14. Investigate and report on the conditioning principles underlying the use of exercise bicycles, rowing machines, and rebounders.

15. Discuss the importance of incorporating physical fitness into one's lifestyle.

LEARNING ACTIVITIES

- Read about or research methods of determining cardiovascular output (i.e. estimated from oxygen consumption measurements in a variety of different exercise situations).

- Perform tests to measure cardiac output.

- Determine a person's blood pressure and discuss the effects of decrease in elasticity of the arteries on cardiovascular health.

- Take Cooper's 12-minute run test or the Canadian Home Fitness (Step) test.

- Enrol in or observe a session of 'dynafit', or 'jazzercise' and report on the conditioning principles underlying the program.

Resources

Books

Falls, Harold, Ann Baylor and Rod Dishman. *Essentials of Fitness.* Philadelphia: Saunders, 1980. In particular, see these practical activities listed in the appendices:

A-1 What Is Your Cardiovascular Risk?
A-2 Type A or B
A-7 Maximal Oxygen Consumption Estimated from Step Test Performance
A-8 Heart Rate Response to a Standardized Workbook
A-9 Determination of Individual Heart Rate
A-10 Test Your Flexibility
A-13 Self-Motivation Assessment Test
A-24 Benson's Relaxation Response

Cooper, Kenneth H. *The New Aerobics*. New York: Bantam Books, 1968.

Hoffman, Norman S. *A New World of Health*. New York: McGraw-Hill, 1976.

Jensen, Clayne R., and A. Garth Fisher. *Scientific Basis of Athletic Conditioning*. Philadelphia: Lea and Febiger, 1979.

Pamphlets (free)

* Health and Welfare Canada.

Ways to Improve Your Lifestyle.
Mealtime Mathematics.
Your Lifestyle Profile.

* Metropolitan Life. *You and Your Health*.

* Occidental Life. *Fitness Head-On*.

These and other pamphlets are usually available from the local office of the Ministry of Health.

Films

Feelin' Great
N.F.B. 21:28 Col 106C 0173 665

Why the human body needs exercise; the sense of well-being that comes from it.

Heart Attack - Prescription for Survival
N.F.B. 55:40 Col 106C 0180 146

A detailed account of the kinds of people who are most likely to be victims of heart disease; the skills of the cardiologist; the possibility of a nuclear-powered artificial heart.

One Way to Quit
C.B.C. 55:48 Col 106C 1076 232

The consequences of smoking, and how to avoid them.

Think Before You Eat
C.B.C. Nature of Things 27:50 Col 106C 0176 167

A hard-hitting look at a national diet that causes more people to die of overindulgence than of too little food.

Periodical Articles

Angier, Natalie. "The Body's Limits." Discover, 2, No. 11 (November 1981).

Collis, Chisholm and others. "Prescription for Fitness." British Columbia Medical Journal (September 1974).

McKean, Kevin. "Exercise." Discover, 3, No. 8, (August, 1982).

Siwolop, Sana. "Eating to Win." Discover, 4, No. 10 (October 1983), 70.

Other Resources

Health and Welfare Canada. Fit Kit ($4.95)

FOODS: ADDITIVES, PREPARATION AND PRESERVATION

Topics

Chemical Additives
Food Preparation
Food Preservation

Purpose

With the increased use of pre-cooked and convenience foods, it is important to understand the nature and purpose of the chemicals added to food. Also significant is the effect that cooking has on the nutritive value of food. Renewed interest in home food preservation and the appearance of foods preserved by newly developed methods makes it desirable for consumers to know more about such methods. This unit is of use to all students, especially those entering the food industry and others interested in applications in the home.

Required Background

It is recommended that students have completed the intermediate Food and Nutrition unit.

Key Ideas

- Substances added to foods to enrich, enhance or preserve them, or to substitute for other ingredients may also have immediate or cumulative effects on the human body.

- The choice of method for the preparation of food should take into account the effect on nutritive value as well as on flavour, texture and appearance.

- A wide choice of effective methods is available for food preservation.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
1. Define additive in the broad sense and in the narrower terms used by government regulatory bodies and legislation.	- Find one or more additives used to preserve food, enhance colour or flavour, enrich foods or reduce calorie content.
2. List reasons for adding substances to foods and give one or more examples of additives which fulfill each.	- Collect lists of ingredients from a wide variety of food packages. Underline additives and state why each is used.
3. Give several examples of "artificial foods". Explain the reasons why such foods are used.	- Find out the ingredients in "artificial foods" such as soya meet substitute, carob products, "zero" calorie soft drinks and non-alcoholic beer.
4. Discuss the relationship that has been shown between some additives and cancer. Name two or more additives no longer used due to their carcinonogenic properties.	- Compare the nutritive value of one or more of the above foods to the actual food for which it is substitute. - Report on the methods used to test an additive for its carcinogenic effects if any.
5. Discuss the possible relationship between additives and possible hyperactivity in children. Name several additives implicated.	- Report on special diets used to help control hyperactivity in children.
6. Explain why monosodium glutamate is no longer added to infant foods. List reasons it is added to sauces, etc.	- Report on the action of monosodium glutamate on proteins.
7. List reasons why fibre is necessary in human diet. Describe what happens when fibre content is too low.	- List several examples of foods very low in fibre and other foods occupying the same places in the diet but rich in fibre.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
8. List three or more reasons for cooking foods.	- Compare cooked and uncooked foods as to appearance and digestibility.
9. Describe several methods of cooking food. Classify as to dry or moist heat (or hot fat).	- Compare the effect of moist heat, dry heat and hot fat on a dough (or pie crust), potatoes and egg albumen.
10. Explain how micro-wave cooking works. Discuss hazards (real or imagined) associated with micro-wave cooking. List advantages and disadvantages of this method.	- Attend a demonstration of microwave cooking. - Report on vitamin loss in cooked vegetables.
11. List effects of cooking on the nutritive value of foods.	- Test the solubility of single-vitamin vitamin tablets in water and in mineral or cooking oil.
12. Classify vitamins as water-soluble, fat-soluble, heat sensitive or heat resistant.	- Heat egg albumen to various temperatures from 70 to 110°C. Compare the texture and volume of the resulting material.
13. List ways of reducing vitamin loss in cooking.	- Collect mold samples from jam, fruit, cheese etc. Compare macro- and micro-scopic appearances.
14. Describe the effect of heat on the protein molecule.	
15. List causes of food spoilage, stating which are microbial and which are chemical.	- Grow bread mold. Determine the optimal temperature for its growth. Demonstrate the effect of mold inhibitors on its growth.
16. Explain what "food intoxication" means. Describe the conditions which encourage the growth of organisms causing botulism and staphylococcal food poisoning.	- Report on home or commercial cheese- or yoghurt-making.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
17. List several food products made by the action of desirable micro-organisms.	- Visit a commercial dairy and watch the pasteuriztion process. Find out what tests are done on milk products to ensure their safety to consumers.
18. Describe the process of pasteurization. List several foods that are pasteurized and the temperature used to process each.	- Visit a fruit, vegetable or fish cannery. Find out the temperatures, pressures and times used in processing.
19. Compare the canning method used for acid and non-acid fruits and vegetables. Give examples of foods in each group.	- Visit a meat-packing, cold storage or other such plant. Report on temperatures used for storage of products, how long storage is continued, and if any other method (such as replacing air with nitrogen etc.).
20. Define osmotic pressure. Give examples of food preservation by high osmotic pressure.	- Report on some specialized food preservation method such as freeze-drying. Tell the advantages of this method, any problems it presents and why it is particularly suited to a particular product.
21. Describe the ideal conditions for freezing foods. Explain why foods should not be re-frozen once thawed and why frozen foods deteriorate in quality after a time.	
22. Differentiate freezing and cold storage in terms of temperature.	
22. Explain what is meant by freeze-drying and why freeze-dried products can be stored at room temperature. List products preserved this way.	

LEARNING OBJECTIVES	LEARNING ACTIVITIES
23. Explain why vacuum packing is used for certain dry solid products and what type of food spoilage this method prevents.	
24. List, describe and give examples of products preserved by various new methods such as ultra-high frequency treatment, and by combinations of methods such as drying and vacuum packing.	

Resources

Books

British Columbia. Ministry of Education. *Encyclopedia of Food Chemicals*. Victoria: Publication Services, 1970.

Cameron, Allan. *Science of Food and Cooking*. Toronto: Gage, 1973.

DeLong, Deanna. *How to Dry Foods*. Tucson, Arizona: H.P. Books, 1979.

Pim, L.R. *The Invisible Additives: Environmental Contamination of Food*. Toronto: Doubleday Canada, 1981.

Rombauer, Irma S. and Marion R. Becker. "The Foods We Eat", and "The Foods We Keep". In *Joy of Cooking*. New York: New American Library, 1975.

Waxter, Julia B. *The Science Cookbook*. Belmont, Calif.: Pitman, 1981.

Pamphlets (free)

Agriculture Canada. *Conserve Today to Consume Tomorrow.*
Freezing Foods.

Consumer and Corporate Affairs Canada.
Let the Labels do the Talking.

Health and Welfare Canada.
Food Additives.
Food Additive Dictionary.
Guide to Food Additives.
Health Protection and Food Laws.
Microbial Food Poisoning.
Mould - More Than Meet the Eye

FOOD AND NUTRITION

Topics

Nutritional Principles
Nutrition and Diet

Purpose

In order to understand what constitutes good nutrition, a person should know major food nutrients, their importance to the body and their major dietary sources. With this knowledge, one can then plan healthful diets for normal and specialized purposes.

Required Background

A working knowledge of metric measurement, especially of weight and volume. Some knowledge about the constituents of common foods.

Key Ideas

- Essential nutrients in the human diet perform different key functions in the maintenance of a healthy body.
- Foods vary as to their content of essential nutrients.
- A well-balanced diet includes sufficient of each nutrient group.
- Diets designed for special purposes must also contain a balance of essential nutrients.

LEARNING OBJECTIVES

11. List factors which influence weather and climate patterns.

12. Define humidity, relative humidity and dew-point and explain how each is measured or determined.

13. Describe cirrus, cumulus and stratus clouds.

14. Explain what fog is and how it forms.

15. Relate precipitation to cloud type.

16. Describe the conditions which result in rain, hail, sleet and snow: explain how these four forms of precipitiation differ.

17. Describe how rain, snow and total precipitation are measured.

18. Explain how wind speed is measured and the terminology used to describe wind direction and speed.

19. Define hurricane, typhoon, and tornado.

20. Explain what causes thunder and lightning and list several precautions one should take in a thunderstorm.

LEARNING ACTIVITIES

- Draw a world map and show the major climate zone.
- Collect pictures illustrating climate and human activities associated with the seasons in each climate zone.
- Read local accounts of weather 50 or 100 years ago. Discuss the possible causes of any changes in weather and the effect these changes have had on people's lives.
- Use or make instruments to measure relative humidity.
- Find illustrations of cloud types.
- Keep a cloud diary with observations of cloud type, estimated height and associated weather.
- Copy descriptions and literature (prose or poetry) of clouds, or other weather. Mount the excerpts alongside appropriate pictures.
- Use the Beaufort scale to estimate wind speed.
- Find someone who has experienced a hurricane, typhoon, tornado or blizzard and write out or tape record a description of it.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
21. Explain what an air mass is and what causes warm and cold air masses.	- Draw a diagram to explain what happens in a thunderstorm.
22. Describe weather patterns associated with a warm front and with a cold front.	- If you live in an area where thunderstorms are common, make a poster showing people what to do in one.
23. Define anticyclones and cyclones and describe the air pressure and movement associated with each.	- Draw diagrams of air masses and fronts with labels explaining the characteristics of each.
24. Describe the typical climate of a temperate rain forest, desert, arctic tundra, and a tropical rain forest and specify areas of the world where each is found.	- Find illustrations of deserts, temperate and tropical rain forests and arctic tundra and show their locations on a world map.
	- Describe the local climate and contrast it with that of another area.
25. Describe the climate of the local area using appropriate terminology.	- List local resources which could not exist in a different climate.
26. Explain the effect that this climate may have on resource industries, housing, leisure pursuits and clothing in the local area.	- Research and report on the effect of climate on human housing, clothing, food and leisure activities.
27. Explain what the symbols on a weather map mean.	- Study weather maps and find out what the symbols on them mean.
28. List sources of weather information used by meteorologists to predict weather.	- Visit a meteorological station and find out what measurements are made and where this information is used.

Resources

Texts

Heimler. Focus on Life Science: 346-371.

Heimler and Neal. Principles of Science: Book 2: 102-121.

Other Books

Lappe, Frances M. Diet for a Small Planet. New York: Ballantine, 1982.

Longacre, Doris. More-with-Less Cookbook. Kitchener, Ont.: Herald, 1976.

Whitney, Eleanor N., and Eva M. Hamilton. Understanding Nutrition. St. Paul, Minnesota: West, 1981.

Periodical Articles

"Do Diets Work?" Science '82 (March 1982), 43-50.

Siwolop, Sana. "Eating to Win." Discover, 4, No. 10 (October 1983), 70.

Pamphlets (free)

Health and Welfare Canada. Canada's Food Guide Handbook.
Food and Your Heart.
Nutrient Value of Some Common Foods.
Shopping for Food and Nutrition.

Other pamphlets are available from the Canadian Diabetes Association, Canadian Heart Foundation and local Health units.

Film

Think Before You Eat.

Other Resources

"Dial-a-Dietician" (Vancouver) 254-7821.

WEATHER AND CLIMATE

Topics

Components of Weather
Effect of Weather and Climate on Human Life
Weather Prediction

Purpose

Weather is the result of a number of atmospheric factors. By studying these factors and how they are measured, one can better understand the meaning of short- and long-term weather predictions. Weather and climate affect many aspects of every person's life; thus, it is useful to understand the methods and possible results of human attempts to change weather patterns. This is a general interest unit, especially useful for those planning careers such as agriculture, aviation, marine navigation or geology.

Required Background

None.

Key Ideas

- Weather is the net effect of a number of measurable components, including wind, temperature, air pressure, humidity and precipitation.

- Climate represents a generalization of weather patterns over a period of time.

- Weather and climate affect many aspects of human life.
- Scientists use information from a variety of sources to predict weather.
- Attempts have been made to control certain weather phenomena.

LEARNING OBJECTIVES

1. Define weather and climate.
2. Define atmospheric pressure and explain how it is measured.
3. List factors which determine air pressure.
4. Discuss the effects of solar radiation on the earth's atmosphere.
5. Define radiation, convection and conduction in terms of the earth's atmosphere.
6. Describe the effect of uneven heating on the atmosphere.
7. Define Coriolis force and explain how it affects the circulation of air in the earth's atmosphere.
8. Explain the cause of sea and land breezes.
9. Use a map or globe to show the location of the major wind systems of the world.
10. Name the five major climate zones, locate them on a world map or globe, and describe the seasonal changes in each zone.

LEARNING ACTIVITIES

- Use reference books to define weather and climate.
- Use a mercury, aneroid or homemade barometer to measure air pressure or changes in air pressure.
- Describe local weather conditions associated with high and low barometric pressures and with rising and falling pressures.
- Draw a diagram or make a model to demonstrate solar radiation.
- Make diagrams of radiation, convection and conduction.
- Use dye in water to illustrate convection currents.
- Measure temperature change with distance from a radiant heat source.
- Draw diagrams to illustrate Coriolis force and its effect on world-wide air circulation.
- Draw diagrams illustrating land and sea breezes and when they occur.
- Use a plastic overlay on a world map to illustrate major wind systems.

LEARNING OBJECTIVES

11. List factors which influence weather and climate patterns.

12. Define humidity, relative humidity and dew-point and explain how each is measured or determined.

13. Describe cirrus, cumulus and stratus clouds.

14. Explain what fog is and how it forms.

15. Relate precipitation to cloud type.

16. Describe the conditions which result in rain, hail, sleet and snow: explain how these four forms of precipitiation differ.

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20. Explain what causes thunder and lightning and list several precautions one should take in a thunderstorm.

LEARNING ACTIVITIES

- Draw a world map and show the major climate zone.
- Collect pictures illustrating climate and human activities associated with the seasons in each climate zone.
- Read local accounts of weather 50 or 100 years ago. Discuss the possible causes of any changes in weather and the effect these changes have had on people's lives.
- Use or make instruments to measure relative humidity.
- Find illustrations of cloud types.
- Keep a cloud diary with observations of cloud type, estimated height and associated weather.
- Copy descriptions and literature (prose or poetry) of clouds, or other weather. Mount the excerpts alongside appropriate pictures.
- Use the Beaufort scale to estimate wind speed.
- Find someone who has experienced a hurricane, typhoon, tornado or blizzard and write out or tape record a description of it.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
21. Explain what an air mass is and what causes warm and cold air masses.	- Draw a diagram to explain what happens in a thunderstorm.
22. Describe weather patterns associated with a warm front and with a cold front.	- If you live in an area where thunderstorms are common, make a poster showing people what to do in one.
23. Define anticyclones and cyclones and describe the air pressure and movement associated with each.	- Draw diagrams of air masses and fronts with labels explaining the characteristics of each.
24. Describe the typical climate of a temperate rain forest, desert, arctic tundra, and a tropical rain forest and specify areas of the world where each is found.	- Find illustrations of deserts, temperate and tropical rain forests and arctic tundra and show their locations on a world map.
25. Describe the climate of the local area using appropriate terminology.	- Describe the local climate and contrast it with that of another area. - List local resources which could not exist in a different climate.
26. Explain the effect that this climate may have on resource industries, housing, leisure pursuits and clothing in the local area.	- Research and report on the effect of climate on human housing, clothing, food and leisure activities.
27. Explain what the symbols on a weather map mean.	- Study weather maps and find out what the symbols on them mean.
28. List sources of weather information used by meteorologists to predict weather.	- Visit a meteorological station and find out what measurements are made and where this information is used.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
29. Discuss the factors for and against artificial weather modification. 30. Explain methods used to induce rainfall. 31. Discuss the effect human activities such as industry, fossil fuels, land clearing may have on weather. 32. Describe the "greenhouse effect" explaining its causes and possible effects.	- If at the coast, find out when small craft, storm and wind warnings are issued. In the interior find out about snow advisory warnings. - Set up a classroom weather station. - Watch weather reports on T.V. and list the different sources of the information presented. - Try predicting weather. - Collect popular "weather sayings" and determine if there is any scientific basis for each. - Find out if any federal or provincial regulations exist concerning cloud-seeding and other methods of weather modification. - Find out what chemical or other methods are used to modify weather and how each is supposed to work. - Engage in a debate on weather modification including such issues as cost and side-effects as well as moral-ethical arguments. - Draw a diagram of the "greenhouse effect". - Write a description of the local area in the event that average temperature was 10°C higher, or 10°C lower.

Resources

Texts

Bishop, Sutherland and Lewis. Focus on Earth Science: 144-186.

Heimler and Neal. Principles of Science: Book 1: 220-259.

Other Books

Bova, Ben. Man Changes the Weather. Reading, Mass.: Addison-Wesley, 1973 (easier reading level).

Horstein, Reuben A. The Weather Book. Toronto, McLelland Stewart, 1980.

Rue, Walter D. Weather of the Pacific Coast. Vancouver. Gordon Soules, 1978.

Environment Canada. Weather Ways. Ottawa: Supply and Services Canada, 1978.

Periodical Articles

"Computing Climate." Science '82 (May 1982): 54-60.

"Fire and Ash: Darkness at Noon." National Geographic. 162, No. 5 (November 1982): 660-684.

"Hurricane!" National Geographic, 158, No. 3 (September 1980): 346-370.

Pamphlets (free)

Environment Canada.
Knowing the Clouds.
Knowing Weather.
Making the Most of the Forecast.
Mapping Weather.
Weather Satellites.

Films

Above the Horizon
20:00 NFB 106C 0164 168

The Climate of North America
16:00 106C 0162 004

The Desert
27:40 106C 0176 227

Of All Seasons
24:00 106C 0175 557

The Origins of Weather
12:00 106C 0163 004

WORK, HOME AND RECREATION SAFETY

Topics

Fire and Accident Prevention
Poison Control
Recreation Safety
Basic First Aid
Survival Techniques in Cold Water or Winter Conditions
Hot Weather Hazards and Precautions

Purpose

This general interest unit examines situations that may threaten the safety and survival of individuals at work, at home, or in recreation. Emphasis is on knowledge and application of appropriate procedures in the event of an accident or other emergency.

Required Background

None.

Key Ideas

- Prevention remains the best defence against accidents.
- A well-informed individual can calmly assess the situation and apply effective principles of treatment or survival in case of an accident or sudden illness.

LEARNING OBJECTIVES

1. State the requirements of a fire and explain how fires are classified.
2. Name several types of fire extinguishers and discuss the appropriate use of each.
3. State the location of the nearest extinguisher, its type and method of operation.
4. Discuss some causes of fires and recognize possible dangerous situations in which fires could start in the home.
5. List the precautions to be taken against home fires and the procedures to be followed in the event of one.
6. Name and recognize examples of electrical hazards.
7. List precautions to be taken against electrical injuries and describe the prescribed method of treatment for a victim of electrical (blue) shock.
8. List five of the most common poisons found around the house and several precautions to be taken to prevent poisoning.
9. Identify hazards associated with common household materials such as fiberglass, paint, solvents, glues, and list appropriate precautions.

LEARNING ACTIVITIES

- Visit the local fire hall or have fire fighters come and talk about their work.
- Locate the nearest extinguisher and determine for what types of fires it would be useful.
- List precautions to be taken against fires starting at home or at work.
- Locate nearest exit from the building: plan appropriate methods of escape from home and work.
- Discuss various overload protecting devices and explain how they operate.
- List precautions to be taken at home or at work to prevent electrical injuries.
- Discuss some of the precautions to be taken when handling medicines, cleaning agents or insecticides.
- Visit local Health Unit or have a doctor come and talk about poisons, preventative measures and proper treatment.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
10. State the proper treatment for all major types of poisoning.	- Make an inventory of poisons at home.
11. List the basic first aid and survival equipment that should be carried at all times when going on recreational or other outings.	- Make a basic first-aid or survival kit to carry when out in the woods or in a boat.
12. State several precautions to increase the chances of rescue should one become lost in the bush.	- Discuss the importance of letting people know where one is going and when one plans to return and how this aids rescue measures.
13. Display several different distress signals and explain how they may be used in the bush.	- Discuss the appropriate use of distress signals.
14. Outline methods to keep warm and avoid panic when lost.	- Discuss the importance of proper clothing for warmth and protection, and the priorities of survival.
15. Describe several methods of artificial respiration and state the appropriate conditions for use of artificial respiration or CPR.	- View films or invite guest speakers from the local ambulance service, hospital or health unit to discuss artificial respiration and its appropriate use.
16. Explain the signs and symptoms of shock, the circumstances under which shock might occur, and the general treatment for shock.	- Visit the local emergency ward or ambulance service to view the equipment used to prevent or minimize shock due to trauma or severe bleeding.

LEARNING OBJECTIVES

17. Outline the correct procedures for the treatment of a wound, sprain or fracture.
18. Explain the difference between minor and major burns and the prescribed treatment for each.
19. Define hypothermia, its recognizable symptoms, and precautions against it.
20. Outline correct procedures for the treatment of hypothermia.
21. Describe cold water safety and survival techniques.
22. Describe hot weather hazards such as heat exhaustion, dehydration and sunburn.
23. Outline methods for the prevention and treatment of persons affected by heat.

LEARNING ACTIVITIES

- Invite a guest speaker to discuss shock, its causes and proper treatment.
- List and discuss basic first aid procedures.
- Attend the Safety Oriented First-Aid Course (SOFA).
- Study the cold water survival chart: relate it to the conditions of any local bodies of water.
- Visit or invite a member of the coast guard or forestry service to discuss hypothermia and cold-water survival techniques.
- List the symptoms of hypothermia and discuss appropriate means to rewarm a victim.
- List the symptoms of heat exhaustion and dehydration, and research appropriate methods of prevention and treatment.
- Compare the treatment of people with sunburn with that of other burn victims.

ADDITIONAL OBJECTIVES AND ACTIVITIES

See also the intermediate unit on Consumer Chemistry.

Resources

Books and Pamphlets

British Columbia. Ministry of Education. VAST 3 Science. Book 1, Unit 2.

British Columbia. Ministry of Lands, Parks and Housing: Parks and Outdoor Recreation Department.

ABC's of Wilderness Survival (pamphlet)
Beware of Hypothermia (pamphlet)
Outdoor Safety and Survival (booklet)

Green, Martin I. A Sigh of Relief: The First-Aid Handbook for Childhood Emergencies. New York: Bantam, 1977.

St. John's Ambulance Society. Emergency First Aid: Safety-Oriented.

Films

The Unplanned
19:30 NFB Col 106C 1071 568
An industrial accident prevention film illustrating two basic accident prevention tenets. Examples are taken from a large machine shop.

Anthony Mazzocchi Talks About Chemicals and the Workers
9:10 NFB Col 106C 0178 528

Dr. Epstein Talks About Distortion of Information
13:02 NFB Col 106C 0178 532

St. John's Ambulance Society and B.C. Parks and Outdoor Recreation Department also have films.

Other Resources

Provincial Emergency Program
B.C. Ministry of Environment
Victoria, B.C. V8V 1X4

Information Division
B.C. Ministry of Forests
Victoria, B.C. V8V 1X4

BIOLOGY

THE CELL: BASIC UNIT OF LIFE

Topics

Cell Structure
Life Activities
DNA and RNA
Tissues, Organs and Systems

Purpose

This is a basic biology unit, dealing with cells and tissues, their organization and specialized functions in life activities. It may be used as a prerequisite for other intermediate or advanced units.

Required Background

None.

Key Ideas

- Cells are the basic units of life. All plants and animals are made of cells.
- All living organisms require energy to carry out life activities such as metabolism, protein synthesis, active transport or reproduction.
- Cells specialize to form tissues, organs and systems.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
1. Identify the main parts of a cell in a cell diagram. 2. Manipulate a microscope and distinguish plant from animal cells. 3. Explain the functions of the parts of a cell. 4. Demonstrate a knowledge of cellular processes controlled by the nucleus. 5. Explain the significance of osmosis and diffusion to living things. 6. Explain how energy is used by living organisms and the forms it takes. 7. Discuss the role of chromosomes and the function of cell division in living things. 8. Differentiate between ordinary cell division and cell division for sexual reproduction. 9. Explain the relationship between cells, tissues, organs and systems and give an example of each. 10. Understand the advantages of a division of labour in the various systems of multicellular organisms.	- Look at a variety of cell types under the microscope to study basic cell parts and their function. - Relate the functions of DNA and RNA in protein formation and explain why proteins differ in different species. - Cite examples of the effects this difference in proteins has on attempts to transplant tissues. - Compare and contrast osmosis and diffusion by performing experiments, using laboratory materials to demonstrate each process. - Describe and draw the ATP-ADP cycle showing how it affects the amount of chemical energy stored in a cell. - Examine cell models and discuss the changes that occur in the surface-to-volume ratio as a cell grows, and hence the reason for cell division. - Use models or charts to observe the differences between sexual and asexual reproduction. - Examine prepared slides of muscle, skin and blood with a microscope and observe the similarities and differences.

Resources

Texts

B.C. Ministry of Education. VAST 4 Biology. Unit 3, Topic A.

Heimler. Focus on Life Science. Unit 2, Chapter 2.

Heimler and Neal. Principles of Science: Book 1. Unit 4, Chapter 13.

Films

Beyond the Naked Eye
18:04 NFB Col 106C 0173 035

A view of the living, pulsating universe contained in a single drop of water from a fish aquarium.

DNA
10:40 NFB Col 106C 0168 174

The genetic material DNA is described and illustrated in this film by colour animation. Mutations are also discussed.

Learning About Cells
16:00 GS-689 VLS-168 (videotape)

Presents cells as independent, dynamic units; cell structure, cell division and specialization; shows nucleus, cytoplasm, chloroplasts, mitochondria, and electron micrograph of rods and cones of the eye.

What is Life?
8:22 NFB Col 106C 0170 013

This animated film provides lucid explanations with excellent colour and effect.

Filmloops

An Inquiry: The Importance of the Nucleus BSCS (4 min)

Mitosis. BSCS (4 min)

CLASSIFICATION AND DIVERSITY OF LIFE

Topics

Features of Living Things
Scientific Names
Classification

Purpose

The theme of this unit is the diversity of life and how scientists use the binomial system of nomenclature. Students will acquire a knowledge of the scientific classification of living things. The unit will be especially valuable as preparation for more advanced biology and for programs in health and related fields.

Required Background

The intermediate unit on The Cell.

Key Ideas

- Classification is based on the similarities, differences and relationships between living organisms.
- Living things can be classified into 5 main groups or Kingdoms - monera, protista, fungi, planta, animalia.
- Scientific names are based on the binomial system.
- Scientific names (genus and species) for living things are the same throughout the world.

LEARNING OBJECTIVES

1. Describe the features of living things that distinguish them from non-living things.
2. List the life processes necessary to keep an organism alive.
3. Explain how DNA controls the features of an organism.
4. Explain that each species has distinct traits which make it different from other species.
5. Explain the basis upon which living things are classified.
6. Describe the advantages of scientific names over common names.
7. Explain how new species come into being and why some may disappear.

LEARNING ACTIVITIES

- List the special features or qualities that separate living things from the non-living.
- Observe objects or pictures and classify them as living or non-living.
- Perform experiments to show that all life activities involve physical and chemical changes within cells and that all living things require a continuous source of energy.
- Examine methods of classification used in the yellow pages of a telephone book or in a library.
- Visit a pet store, zoo or plant conservatory and make a list of the many different kinds of plants and animals that are present.
- Look up the scientific names of these organisms and group them by Kingdom and phylum.
- Organize a field trip to a nearby field, park or vacant lot to collect and later mount and study insects.

Resources

Texts

B.C. Ministry of Education. VAST 4 Biology. Unit 1, Topic A.

Heimler. Focus on Life Science. Unit 2, Chapter 2.

Heimler and Neal. Principles of Science: Book 1. Unit 4, Chapter 13.

Films

Butterflies, Beetles and Bugs
16:30 NFB Col 106C 0161 078

This film explores the insect world showing levels of taxonomy, phyla, orders, etc. It looks at classification systems and explains that the point is not to remember all the divisions but to note why and how they are made.

What is Life?
NFB Col 106C 0170 013

This animated film begins by distinguishing non-living from living organisms. It shows clearly and succinctly what scientists in biophysics and biochemistry now perceive as the facts of life concerning evolution and the genetically determining factor of the DNA molecule.

Periodical Article

Gorman, James. "The 40-Million-Year-Old Bug." Discover, 3, No. 5 (May 1982), 36.

Preserved in amber, the muscles and membranes of a gnat have survived, giving scientists information about the cells of an ancient insect.

DISEASE

Topics

Causes of Disease
Transmission of Disease
Disease Treatment and Control

Purpose

Various types of infectious and non-infectious diseases of human beings are studied. Causative agents, means of transmission, and general types of treatment are examined along with personal and public health measures for prevention.

Required Background

A general knowledge of human anatomy will be useful.

Key Ideas

- Diseases result from the reaction of the body to various external and internal sources of stress.

- Infectious diseases are caused by a variety of agents which may be transmitted to humans in a number of ways.

- The treatment of a disease can be related to its cause and the effect which [illegible] has on the body.

- Accurate diagnosis often prevents serious illness, ensures appropriate treatment and speeds recovery.

- The individual and public agencies can co-operate to prevent the spread of infectious diseases.

LEARNING OBJECTIVES

1. Classify diseases as infectious, degenerative or genetic.
2. Give examples of infectious diseases caused by bacteria, viruses, fungi, and various parasites.
3. Discuss the major ways by which diseases are transmitted:
   - airborne
   - direct contact
   - insect-carried
   - wound infections
   - sexually transmitted
   - contaminated water and food

   Give examples of several diseases transmitted in each way.
4. Name several antibiotics, explain the mode of action of antibiotics and list several diseases treated with them.
5. Explain the terms: antibiotic, allergy and antibiotic resistance.
6. Explain why viral diseases are difficult to treat with antibiotics or chemical agents.
7. Discuss the use of antitoxins in the treatment of some diseases.

LEARNING ACTIVITIES

- List common infectious diseases, especially the "childhood" diseases.
- List diseases caused by genetic defects.
- Read about theories of the causes of cancer.
- Watch a film or read an article on genetic diseases and counselling.
- Examine microscopic slides of types of bacteria.
- Find illustrations of viruses which cause human disease.
- List common fugus and parasitic diseases found in temperate climates.
- Classify well-known infectious diseases by the way each is transmitted.
- Make posters illustrating ways diseases are transmitted or how to prevent their transmission.
- Report on the discovery and commercial production of penicillin.
- Report on how new antibiotics are discovered and tested.
- Visit a hospital laboratory and learn how specimens are cultured and how technicians determine antibiotic sensitivity.

LEARNING OBJECTIVES

8. Give examples of the use of chemotherapy, radiation and surgery as treatments for disease.

9. Explain how natural and acquired, active and passive immunity develop in the human body.

10. Define vaccine, toxin and antitoxin and give examples of each.

11. List ways to prevent transmission of disease through food and water.

12. Explain what a coliform count is and why it is significant.

13. Discuss the advantages and disadvantages of spraying to kill insects which transmit disease.

14. List the responsibilities of the citizen to prevent the transmission of disease.

15. Describe self-examination for several forms of cancer.

16. Discuss the relationship of smoking to lung cancer and other respiratory diseases.

LEARNING ACTIVITIES

- Report on how antibiotic allergies develop and what steps people with these allergies could take.
- Watch a film about viruses and how they multiply.
- Have a doctor or public health worker speak on immunity.
- Write to the Canadian Cancer Society for pamphlets about cancer therapy, and cancer self-examination.
- Write to the Atomic Energy Commission for material on radiation therapy.
- Make posters reminding people to keep their immunizations up to date.
- Find out what immunizations are required for travel abroad.
- Help out at an immunization clinic at a local Health Unit.
- Make posters stressing cleanliness by food handlers.
- Find out where the local community obtains drinking water and what steps are taken to ensure its purity.

ADDITIONAL ACTIVITIES

- Find out public health regulations concerning the location of a household well, how to collect well-water samples and have them tested.

- Observe a coliform count in a public health laboratory.

- Find out what is required for pasteurization.

- Visit a local dairy farm and observe the cleaning procedures used.

- Go on a field trip to a cannery, food-processing plant, dairy, or meat packer.

- Find out local and provincial regulations concerning cleanliness in food industries, restaurants and institutional kitchens.

- Make posters about the effect of cigarette smoking on the body.

- Show a film on smoking and cancer.

A HEALTH FAIR could be organized as an institutional or community event and could centre around the visit of the mobile chest X-ray unit, immunization clinic, etc. It would include posters, films, displays and free literature tables on cancer, immunization, nutrition and other public health topics. Probably organization should be a cooperative effort with the local Health Unit, but publicity, posters, set-up and personnel for tables could come from the Adult Basic Education class. It could be a final activity associated with the units on Disease, Food and Nutrition, and Fitness and Health or several of the advanced biology units.

Resources

Texts

Heimler. *Focus on Life Science*: 208-233, 412-415.

Heimler and Neal. *Principles of Science: Book 2*: 122-139.

Other Books

Mader, Sylvia S. *Inquiry into Life*. Dubuque, Iowa: Wm. C. Brown, 1982.

Volpe, Peter E. *Man, Nature and Society*. Dubuque, Iowa: Wm. C. Brown, 1972.

Periodical Articles

Diagnosis

Grady, Denise. "Shedding Light on the Breast." *Discover*, 2, No. 3 (March 1981). A new variation on an old idea helps find cancer of the breast.

McKean, Kevin. "Beaming New Light on the Brain." *Discover*, 2, No. 12 (December 19810. Coloured maps of the brain's electrical activity helps spot epilepsy and other diseases.

McKean, Kevin. "Diagnosis by Computer." *Discover*, 3, No. 9 (September 1982). The story of CADUCEUS, a diagnostic computer system.

Treatment

Angier, Natalie. "Bugs That Won't Die." *Discover*, 3, No. 8 (August 1982). Many deadly bacteria are now resistant to antibiotics. Can new drugs defeat them?

Grady, Denise. "Aspirin - Is the Warning Necessary?" *Discover*, 3, No. 8 (August 1982). The old standby may be a life-saver for adults, but could be dangerous for children.

______________. "DMSO: The Best Thing Since Aspirin." *Discover*, 3, No. 1 (January 1982). The controversial wonder drug may soothe aches, pains and bruises, but its critics call it "snake oil".

___________. "The Selling of Oraflex." Discover, 3, No. 10 (October 1982). A new arthritis drug was suddenly withdrawn from the market. What happened?

Langone, John. "Leukemia: A Brighter Outlook." Discover, 2, No. 12 (December 1981). Chemotherapy, radiation and bone marrow transplants offer new hope for children once doomed to die.

___________. "Robert Weinberg: Scientist of the Year." Discover, 4, No. 1 (January 1983), 36.

An experimental biologist at MIT symbolizes the new research in cancer-causing genes.

Wingerson, Lois. "Found: Cancer Genes." Discover, 3, No. 6 (June 1982). The seeds of cancer are present in normal DNA.

___________. "Training the Mind to Heal." Discover, 3, No. 5 (May 1982). Some researchers are finding that the old saying, "It's all in your mind" could be true.

Pamphlets (free)

American Cancer Society (also distributed by Canadian Cancer Society). Cancer Word Book.

B.C. Lung Association. Your Health (quarterly periodical).

Canadian Cancer Society. Cancer: Prevention.
It's up to You to Take the First Step.
Miscellaneous other titles.

Health and Welfare Canada. Be Wise, Immunize.

Metropolitan Life Insurance. Your Child's Health Care.

Films

About VD.
13:38 NFB 106C 0174 123

Question of Immunity.
13:04 NFB 106C 0171 034

HUMAN BIOLOGY

Topics

Structure of the Human Body
Major Systems of the Body

Purpose

This is an introductory biology unit presented from a general education approach. For a more detailed or specialized approach, two advanced units have been prepared: these are titled Body Systems 1 and 2, and will be found later in this guide.

Required Background

The intermediate unit on Cells - the Basis of Life.

Key Ideas

- The design of the human body is such that there is a remarkable interdependence between the muscular and skeletal systems, although each is unique and highly specialized.
- The major body systems (circulatory, respiratory, excretory, digestive, and nervous) although each highly specialized for one particular purpose, could not function properly without a clear division of labour and close interrelationships.

LEARNING OBJECTIVES

1. Examine a human skeleton and identify or label the major bones.
2. Label the various tissues in a cross-section of a bone.
3. Compare and contrast bone, cartilage and ligaments.
4. Identify the major types of muscles, and compare the function of voluntary and involuntary muscles.
5. Label a diagram of the human heart and trace the path of blood through the heart.
6. Identify the organs of circulation: the arteries, veins, capillaries, and explain their respective functions.
7. Compare and contrast pulmonary, systemic, renal and portal circulation.
8. List the major components of the blood and discuss the functions of each.
9. Describe the lymphatic system and its functions.
10. Diagram and explain the function of the organs of the body involved in respiration (lungs, heart, blood).

LEARNING ACTIVITIES

- Relate the different components of the skeletal system to different functions with the aid of charts, diagrams, models or a skeleton.
- Examine cross-sectional and longitudinal slides of bone cartilage and ligaments, to relate the anatomy of each to their function.
- Experiment to demonstrate the inability of an individual to consciously control an involuntary reflex.
- Label and complete a diagram of the human heart and indicate the direction of blood flow.
- Measure some functions of the circulatory system (blood pressure, resting heart rate and recovery rate after exercise, clotting rate and level of hemoglobin).

LEARNING OBJECTIVES

11. Discuss the role of hemoglobin and the need for gas exchange in body cells.
12. Examine a model of a kidney, identify the various parts and indicate the function of each part.
13. Diagram or label the parts of the human digestive system and indicate the function of each part.
14. Distinguish between chemical and physical digestion.
15. Describe the major parts of the nervous system (brain and spinal cord).
16. Compare and contrast sensory neurons, motor neurons and associative neurons.
17. Describe the autonomic nervous system and state its function.
18. Compare and contrast a conditioned reflex with a natural reflex.

LEARNING ACTIVITIES

- On a diagram trace the path taken by air entering the body and explain the function of the major organs of the respiratory system.
- Illustrate the path of urine and name the main body parts involved, with an explanation of their functions.
- Experiment to demonstrate the action of digestive juices on starch, protein and fats.
- Design experiments to test how environmental conditions affect the rate of an enzymatic reaction such as pH temperature and concentration.
- Identify, using prepared diagrams, the three major types of neurons (sensory, motor, associative) and describe the function of each.
- Differentiate between simple and conditioned reflexes given a list of examples.

INTEGRATING HUMAN BIOLOGY WITH OTHER AREAS OF ADULT CONCERN

The instructor may wish to provide opportunities for students to:

I-1 Appreciate the impact of technology in the field of biomedical research.

I-2 Evaluate the effects on society of biomedical technology and the possibilities of robots that see, feel, and make simple judgments.

I-3 Relate food energy content, human activities and metabolism.

I-4 Appreciate the role of medical technology in allowing selected individuals an extension on life they may not otherwise have had e.g. pace makers, artificial heart, kidney, lung.

I-5 Evaluate the advances of medical technology on society in terms of cost, benefits, ethics and increased population size.

I-6 Predict the effects of various forms of environmental pollution on the respiratory system.

Some possible activities to aid integration including the following:

- Do library research on the advances in biomedical research and on the role of "the chip" in biomedical technology.
- Invite, or interview a doctor interested in holistic medicine to discuss the relationship between lifestyle, eating habits and good health.
- Research or read about various environmental pollutants and their effects on the major body systems.
- Do a library search or investigate some technological advances to extend the senses or the nervous system.
- Conduct interviews or read and research information to determine the effect of robots on our society.

I-7 Appreciate how one's lifestyle affects the body system.

I-8 Develop an awareness of the complexity and fragility of the nervous system.

I-9 Appreciate the relative importance of the senses and the role of technology in extending them.

I-10 Investigate how the nervous system adjusts itself to situations involving sensory loss e.g. compensation and sensory extension.

I-11 Study the mechanisms by which drugs affect the nervous system.

Resources

Texts

Heimler. Focus on Life Science. Unit 4, Ch. 1-3; Unit 2, Ch. 3.

Heimler and Neal. Principles of Science: Book 2. Unit 1, Ch. 2-5.

Other Books

Berry, Gordon S., and Harold P. Gopaul Biology of Ourselves: A Study of Human Biology. Rexdale, Ont.: Wiley Canada, 1982.

Gottlieb, Joan S. Wonders of Science: The Human Body. Austin, Texas: Steck-Vaughn, 1977 (easier reading level).

Jacobson and others. The Human Organism: Science and Daily Living. New York: American Book Company, 1969.

Scarrow, H.R. Bodyworks. Toronot: Globe/Modern Curriculum Press, 1979.

Periodical Articles

Grady, Denise. "An Impossible Bike Ride." Discover, 3, No. 7 (July 1982), 59. Computers that flex paralyzed muscles will give the handicapped new ways to exercise and get around.

________. "The Plug-in Artificial Heart." Discover, 2, No. 4 (April 1981), 77. An implantable plastic and aluminium pump can replace a heart that fails, but its use raises disturbing questions.

Lagone, John. "Replacing Damaged Bones." Discover, 2, No. 3, (March 1981), 64. Instead of using steel and plastic, orthopedic surgeon are repairing the skeleton with bones from cadavers.

Weintraub, Pamela. "The Brain: His and Hers." Discover, 2, No. 4 (April 1981), 15. Mena dn women think differently. Science is finding out why.

________. "Raising the Robots' IQ." Discover, 2, No. 6 (June 1981), 76. Scientists are devising machines that see, feel, walk, make simple decisions and reproduce themselves.

See also: Discover 4, No. 2 (February 1983). "Special Report: Replacing the Heart."
National Geographic, October 1982. Article on the chip and biomedical research.
Newsweek, Dec 6-12, 1982. Cover story on artificial heart.

Films

Heart Attack - Prescription for Survival
55:40 NFB Col 106C 0180 146

This film provides a detailed account of the kinds of people who are most likely to be victims of heart disease. It also examines the cardiologist's skills and looks at the possibility of a nuclear-powered artificial heart.

Left Brain - Right Brain
50:35 CBC: Nature of Things Col 106C 0179 295

Research confirms that the two halves of the human brain tend to specialize in different ways of thinking and perceiving.

Mind and Hand
27:55 CBC Col 106C 0A4203

By studying the electrical impulses that originate in the brain and are then transmitted via nerve channels to the muscles, scientists are trying to answer the question, "What happens when a person makes a voluntary movement"?

Patterns of Pain
27:50 CBC 106C 0A8 430

An exploration of the perception of pain in the human nervous system, and different techniques to alleviate pain.

Think Before You Eat
27:50 CBC: Nature of Things Col 106C 0176 167

A hard-hitting look at the national diet that causes more people to die of overindulgence that from too little food.

HUMAN DEVELOPMENT AND BEHAVIOR

Topics

Behaviour and the Senses
Reproduction
Birth Control

Purpose

This unit provides an overview of the human organism. It is intended for students interested in the topic but not requiring an in-depth study. For a more detailed or intensive unit, see advanced units Body Systems 1 and 2, Human Inheritance and Humand Growth and Reproduction.

Required Background

It is preferable to have completed the Human Biology unit or otherwise have an understanding of the body systems and their interrelationships.

Key Ideas

- The senses, hormones and many other inborn behavioural patterns (instincts, reflexes, biological clocks or biorhythms) allow organisms to respond to their internal and external environments and thus survive.

- Human reproduction is one of the most highly specialized forms of sexual reproduction.

- Although all forms of reproduction (sexual and asexual) are directly related to the survival of the species - only sexual reproduction produces offspring which are the product of both parents.

- Conception may be prevented by appropriate birth control.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
1. List the sense organs and specify what stimuli they receive.	- Examine models or diagrams of the eye, ear, skin to identify the major parts and discuss their functions.
2. Describe the functions of the endorcrine system.	- Do library research or read about some interesting aspects of the nervous system, such as acupuncture or biofeedback.
3. List the factors which influence human behaviour and explain how a habit is different from a reflex.	
4. Explain why certain activities in organisms and humans occur in regular rhythms.	- Determine body rhythms by charting daily changes in mood, health, appetite, exercise, eating habits, etc.
5. Identify and explain the function of the organs in the male and female reproductive systems.	- Study diagrams of male and female reproductive systems.
6. Describe the importance of the human female menstrual cycle.	- Study a chart showing the cycle of ovulation, buildup and breakdown of the uterine lining.
7. Explain the relationship between the maternal circulation and fetal circulation.	- Review diffusion and osmosis and explain why physicians caution pregnant women on smoking, drinking and the use of drugs.
8. Explain why certain inherited characteristics appear in every generation while others may skip a generation or never show up.	- Construct a family tree for such single gene factors such as PTC, hand span, ear lobes, tongue rolling, widow's peak or hand folding.
9. Describe the manner in which hereditary traits are transferred from parents to offspring.	- Do library research on selective breeding, and such diagnostic tests as PKU, amniocentesis and ultrasound.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
10. Read and interpret a pedigree. 11. Explain the concept of inherited disease. 12. Explain the value of genetic counselling. 13. Describe the princples upon which birth control methods are based. 14. Discuss personal responsibility in the context of population growth and birth control. 15. Appreciate the impact of eugenics on society. 16. Evaluate the advances of genetic engineering.	- Investigate such diseases as cystic fibrosis, sickle cell anemia, Huntington's disease and Down's syndrome. - Invite a local specialist such as a physician or public health nurse to discuss genetic counselling, birth control or other pertinent issues. - Investigate various birth control devices and discuss the merits and limitations of each. - In small group discussion format and using references forecast the problems the populations of the earth face today. - Research recent articles on cloning, genetic engineering and eugenics.

Resources

Texts

Heimler. Focus on Life Science. Unit 5, Chapters 1, 3, and 4.

Heimler and Neal. Principles of Science: Book 2. Unit 2, Chapter 1.

Other Books

Berry, Gordon S. Biology of Ourselves: A Study of Human Biology. New York: Wiley, 1981.

Periodical Articles

Angier, Natalie. "Dr. Jekyll and Ms. Hyde." Discover, 3, No. 11 (November 1982). Premenstral syndrome may drive some women to violence.

Langone, John. "The Quest for the Male Pill." Discover, 3, No. 10 (October 1982).

"Moment of Conception." Discover, 3, No. 10 (October 1982).

See also the following items in SciQuest:

February 1980: Recent genetic discoveries.
July-August 1980: Early discovery of inborn defects in metabolisms.
November 1980: Sexually transmitted diseases.
January 1981: DNA repair mechanisms.
March 1981: The 'extra bit' of DNA.

Films

Contraception: The Hidden Cost
26:52 CBC: Man Alive Col 106C 0178 056

Modern contraception is presented in this film not only as a technique but also as an attitude to living. Counsellors and couples discuss various methods and their implications.

The Differences are Inherited
27:50 CBC: Nature of Things Col 106C 1076 064

David Suzuki uses the fruit-fly to discuss mutations, current genetic research and the relationship of this research to some of the problems suffered by humans.

DNA
10:40 NFB Col 106C 0168 174

The genetic material DNA is described and illustrated by colour animation. Mutations are also discussed.

One-Two-Three-Zero
27:48 CBC: Nature of Things Col 106C 0179 306

The film describes how the first test-tube birth came about and the methods which were used.

The Psychology of Man: An Inquiry into Human Behaviour

A comparison of Freud's and Jung's theories with Watson's theory of behaviour modification.

INDIVIDUAL DISABILITIES

Topics

Mental Handicaps
Neurological and Degenerative Disorders
Visual Impairment
Auditory Impairment
Physical Disabilities

Purpose

Society is trying to assimilate the mentally and physically handicapped into the mainstream of community life. Therefore, a knowledge of the physical causes and consequences of the more common individual disabilities which affect people is useful to everyone, especially those entering health and human service careers.

Required Background

None, but a general background in human biology will be helpful.

Key Ideas

- Mental and physical disabilities have a number of causes and effects, and, in some cases, can be prevented.
- Inability to cope with one aspect of life does not necessarily affect a person's ability to perform normally in other ways.

Unit Outline

The following is a generalized outline. It should be modified to suit the interests of students and instructors and the extent of local resources. Each topic listed may be dealt with under the following headings:

Terminology and definitions
Biological causes
Effect which the disorder has on a person
Assistance available to aid an individual in coping with the disability
Prevention

The first topic, mental retardation, is outlined in more detail than the others, as an indication of how an instructional unit might be developed.

1. Mental Retardation

o Definitions

o Causes

- genetic (Down's syndrome, PKU, etc.)
- prenatal environment (Rubella, Ph incompatibility)
- birth injury and prematurity (cerebral palsy)
- post-natal problems (encephalitis, meningitis, trauma, lead poisoning)
- other causes (rejection, early dietary lack of protein, etc.)

o Effect on the Individual: discuss type of brain damage in general terms (motor skills, reasoning, etc.) and idea that damage is a matter of degree.

- o Assistance Available: this topic lends itself to student research on local problems.

- o Prevention: - genetic counselling
  - amniocentesis
  - maternal health care
  - improved post-natal environment

2. Neurological and Degenerative Disorders

- epilepsy
- poliomyelitis
- multiple sclerosis
- muscular dystrophy and myasthenia gravis
- Parkinson's disease
- Alzheimer's disease

3. Visual Impairment

4. Auditory Impairment

5. Physical Disabilities

- spinal injuries
- effects of trauma and tumors on the brain
- other physically disabling problems which limit a person's life, such as diabetes, dialysis, etc.

Resources

Barnes, Ellen, Carol Berrigan and Douglas Biklen. *What's the Difference?* Syracuse, New York: Human Policy Press, 1978.

Although intended for use by elementary school teachers, this book contains a wealth of basic information about disabilities and an extensive bibliography of books, films, pamphlets, etc., many of which are free or low cost. Although the references are American htere are Canadian counterparts of most organizations mentioned (or the American organization may send single copies to Canadian educators).

British Columbia. Ministry of Education: Continuing Education Division. *Issues and Insights: A Handicapped Awareness Resource Manual*. Victoria, 1981.

Canada. House of Commons. *Obstacles* (Report of the Special Committee on the Disabled and Handicapped). Ottawa: Ministry of Supply and Services, 1981.

Kunc, Norman. *Ready, Willing and Disabled*. Toronto: Personal Library, 1981 (distributed by Wiley and Sons Canada).

CHEMISTRY

CHEMISTRY: INTRODUCTION

Topics

Laboratory Safety
Elements, Compounds and Mixtures
Atoms and Their Structure
Molecules and Ions
Symbols and Formulae
The Periodic Table

Purpose

This is the first of two introductory units in chemistry, the second being Reactions and Equations. Another unit, a more general approach to application of chemistry in everyday life, is entitled Consumer Chemistry.

Required Background

None.

Key Ideas

- When working with chemicals, it is essential to observe certain safety rules and procedures.
- All substances can be classified as elements, compounds, or mixtures.
- Atoms are the simplest units of matter; a number of theories have been put forward to explain their structure.
- Scientists have developed a shorthand system of letters and numbers to represent elements and compounds. Elements are arranged in the Periodic Table according to their atomic structure; basic information about elements can be obtained from this table.

LEARNING OBJECTIVES | LEARNING ACTIVITIES

Instructors without access to conventional laboratory facilities are encouraged to find other ways to implement this unit. The Resource section of this Guide provides ideas and resources for experiments using household equipment in a non-laboratory setting.

LEARNING OBJECTIVES

1. List safety procedures which should be followed during chemical experiments.
2. Explain what to do for a chemical burn.
3. Demonstrate correct ways to heat materials, operate a gas burner (if applicable), pour liquids, etc.
4. Define element, compound and mixture and give examples of each; classify common substances as elements, compounds or mixtures.
5. Define atom.
6. List various theories of atomic structures; explain why some have been discarded and what the currently accepted theory is.
7. Define nucleus (in atomic terms), neutron, proton and electron.
8. Explain what is meant by electron clouds and energy levels.
9. Explain the term ion and how it differs from an atom.

LEARNING ACTIVITIES

- Make safety posters for the classroom or laboratory.
- Have an industrial first aid attendant talk about handling chemicals.
- View a film on lab safety.
- Classify a collection of materials as elements, compounds, or mixtures.
- Demonstrate the union of 2 elements to form a compound with new properties (e.g. iron and sulfur).
- Demonstrate the decomposition of a compound to form two elements (e.g. electrolysis of water).
- Separate various mixtures by physical means.
- Use charts to illustrate atomic structure.
- Make and use flash cards to learn symbols and oxidation numbers of elements and polyatomic ions.
- Use flash cards to learn formulae of compounds.
- Make a display of household or technical chemicals with a simple common name, chemical name and formula for each.

LEARNING OBJECTIVES

10. Give the symbols for most of the common elements.
11. Give the oxidation number (valence) for elements for which symbols are given.
12. Explain what a polyatomic ion is and represent the ammonium, nitrate, hydroxide, sulfate, carbonate, and phosphate ions symbolically, giving the oxidation number for each.
13. Write formulae for compounds for which the chemical name is given (and vice versa).
14. Give the chemical names for common household and other substances such as table salt, baking soda or limestone.
15. Explain how the atomic number of an element is determined.
16. Define atomic mass unit and atomic mass number and how each is determined.
17. Define isotope and give several examples.
18. Explain how elements are arranged in the periodic table.

LEARNING ACTIVITIES

- Make single cards each representing an element on the periodic table.
- Arrange these cards as they would be in the periodic table.
- Read and report on the use of isotopes in medicine, research, industry.
- Use information from the periodic table to write formulae for unfamiliar compounds.
- Write a list of common metals and locate on the periodic table those which are elements.
- Find out uses for one or two unusual metals.
- Read about several metalloids and report on their properties and uses.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
19. Use the periodic table to find the atomic number and average atomic mass of elements.	
20. State common properties of elements in certain groups such as the noble (inert) gases, halogen, alkali earths, etc.	
21. Explain what transition elements are.	
22. Define the terms metal, non-metal and metalloid in terms of the periodic table.	

Resources

Texts

Heimler and Neal. Principles of Science: Book 1: 22-42
Principles of Science: Book 2: 180-222.

Heimler and Price. Focus on Physical Science: 80-139.

Other Books

Madras, Samuel, and others. Basic Modern Chemistry. Scarborough, Ontario: McGraw-Hill Ryerson, 1978: 46-67, 114-126.

Film

Chemical Families
22:00 GS-582 (film) VCH (videotape)

Displays samples of over 70 elements; demonstrates basis for dividing them logically into families; explains atomic numbers and periodic table.

REACTIONS AND EQUATIONS

Topics

Chemical Reaction
Bonding
Factors Affecting Rate of Reaction
Equations
Simple Mass Problems

Purpose

This is the second of two introductory units in chemistry. Upon completion of this unit, a student should have the basic knowledge needed for further study in chemistry or in subjects which require some chemistry background.

Key Ideas

- Elements and compounds react together in a predictable manner.
- Elements unite by different types of inter-atomic bonding.
- The rate of a chemical reaction is dependent on a number of factors.
- Chemical reactions can be written using formulae in the form of an equation.
- The amounts, reactants and products in a reaction can be calculated mathematically.

Instructors without access to conventional laboratory facilities are encouraged to find other ways to implement this unit. The Resource section of this Guide provide ideas for experiments using household equipment in a non-laboratory setting.

LEARNING OBJECTIVES

1. Explain what a chemical formula represents.
2. Give examples of chemical reactions which involve synthesis, decomposition, replacement and double displacement, using names of substances or unbalanced chemical equations (see #7 below).
3. Explain what is meant by ionic, covalent and polar bonding and give examples. of each.
4. Draw diagrams to represent the above bonding types.
5. List a number of factors which affect the rate of a chemical reaction.
6. Define catalyst and give examples of the use of catalysts in the laboratory and in industry
7. Write balanced chemical equations for reactions, given chemical names of reactants and products.
8. Use the periodic table to determine atomic mass units of the reactants and products.
9. Solve mass problems for balanced equations or be able to balance the equation and then solve a mass problem.

LEARNING ACTIVITIES

- Use symbol cards to explain what a formula represents.
- Perform experiments which represent each type of reaction:
  - o combine iron and sulfur
  - o electrolysis of water
  - o place a copper wire in silver nitrate solution
  - o mix sodium chloride and silver nitrate.
- Draw diagrams illustrating types of bonding.
- Show the effect of increased heat on rate of combination of sulphur and iron.
- Compare the amounts of carbon dioxide produced using varying proportions of a dilute acid and sodium bicarbonate.
- Compare the rate of reaction using iron filings and sulphur to using iron chunks and sulphur.
- Demonstrate the need for a catalyst (manganese dioxide) to be able to produce oxygen from potassium chlorate.
- Use the periodic table to find atomic mass units for compounds.

Resources

Texts

Heimler and Neal. Principles of Science: Book 1: 43-64.
Principles of science: Bool 2: 224-242.

Heimler and Price. Focus on Physical Science: 234-255.

Other Books

Madras, Samuel, and others. Basic Modern Chemistry. Scarborough, Ontario: McGraw-Hill Ryerson, 1978: 124-132, 213-226.

SOIL CHEMISTRY

Topics

Chemical Cycles
Essential Elements: The Needs of Plants and How They are Met
Secondary and Trace Elements
Soil pH
Humus and Soil Fertility
Fertilizers
Leaching and Mineralization
Herbicide and Pesticide Residues
Formation and Types of Soil
Composting
Hydroponics

Purpose

With the increased pressure of world population, the wise use of agricultural and marginal land is of growing importance. Students entering agriculture or forestry-related careers, as well as those who will only garden as a hobby, need an understanding of the factors involved in soil fertility. If possible, students should have an opportunity to do simple chemical soil tests using commercial kits.

Required Background

None.

Key Ideas

1. Various natural cycles affect the fertility of soil.

2. Certain elements are necessary for plant growth either in large or trace amounts.

3. Human activity affects the fertility of soil.

LEARNING OBJECTIVES

1. Use diagrams to describe the carbon, nitrogen and water cycles.
2. List the three major plant nutrients, giving the role of each in plant growth and the result of a lack of each.
3. List the secondary elements (calcum, magnesium and sulfur) and describe the role of each in plant nutrition.
4. List several trace elements needed by plants (boron, ablorine, copper, iron, manganese, molybdenum and zinc) and give the importance of each to plants. Give two ways of detecting trace element deficiencies in soil.
5. Explain that pH is a measure of soil reaction and give typical pH ranges for soils.
6. Describe the pH range needed by locally important crops and/or a vegetable garden, fruit trees, etc. Be able to list several plants requiring acidic soils and several requiring alkaline soils.

LEARNING ACTIVITIES

- Make large posters of these cycles.
- Grow plants in vermiculite or sawdust and feed with only one, two or all three nutrients.
- Find out the composition of solutions used in hydroponic greenhouses.
- Research and report on the effect of a lack (or excess) of a trace element on crops grown locally.
- List ways of remediating trace element deficiencies.
- Use indicator paper to measure the pH of soil samples from different places.
- Collect and label samples of substances used to change soil pH.
- Obtain soil samples and determine their relative humus content. Try to relate this to apparent soil fertility.
- Collect samples of humus such as peatmoss, leaf mold, compost, etc.
- Compare permeability and water retention of clay, sand, peatmoss and a mixture of these. Also of the soil samples on which humus content was found.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
7. List ways of changing soil pH. 8. Define humus and list several material sources of soil humus. 9. List ways of increasing humus content and explain how humus is depleted. 10. Discuss the role of humus in soil fertility, permeability water-holding capacity and pH. 11. Interpret the numerical rating (e.g. 6-10-10) on fertilizers. Know the minimum information that must appear on fertilizer packages. 12. List several substances used as sources of N,K,P, in fertilizers. 13. Discuss factors such as solubility, effect on pH and cost which must be considered in fertilizer choice. 14. List the methods of application of fertilizers such as broadcast, landing, foiar sprays, irrigation. 15. List alternatives to chemical fertilizers such as animal manures, green manures, bonemeal, etc. giving the advantages and disadvantages of each, if possible.	- Grow plants in vry clayey soil, pure sand, and in clay-peat, sand-peat and pure peat, watering equally. - Collect fertilizer packages and lebels. List the actual ingredients in various fertilizers. - Find out the usual formulations for special purposes, such as lawns, fruit trees etc. - Find out formulations recommended for starting solutions. - Test soil samples with a commercial soil testing kit. - Find out how soil samples should be taken for laboratory testing. - Know where soil testing is done. - Visit a soil testing laboratory. - Report on 'slow release" fertilizers used in greenhouses and for house plants. - Report on "organic" gardening and farming methods. - Debate the pros and cons of organic growing. - Find out government regulations on labelling organic fertilizers.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
16. Define leaching and mineralization and list the circumstances causing each, the result on soil fertility and ways of preventing these processes and of treating soils affected by them.	- Invite an agriculturist or gardening expert tom speak on fertilizers. - Research and report on the problem of herbicide and pesticide residue in agricultural lands and viable alternatives which leave no residues.
17. Discuss the problem of pesticide and herbicide residues in soil. List several such chemicals which have residual effects and several which are biodegradable or which break-down fairly rapidly when not absorbed by the target organism.	

ADDITIONAL OBJECTIVES AND ACTIVITIES

1. List ways soil is formed and the steps in soil formation.	- Make charts on soil formation.
2. Describe the effect on soil of movement by glaciers, water and wind.	- Report on the origin and kind of soil in your locality. - Study soil maps of Canada, B.C. and the local area.
3. List major soil types and the characteristics of each.	- Ask a soil surveyor to come and describe his work.
4. Describe how to build a compost pile. Explain how the composting process works and the purpsoe of adding lime, soil, or commercial additives to a pile.	- Obtain samples from various levels or stages in composting and test for N.K.P., pH and humus content. - Visit a hydroponic greenhouse.
5. Describe how hydroponic crops are grown. List such crops, especially any grown locally. List advantages and disadvantages of this method as compared with growing plants in soil.	- Set up a small hydroponic system in the classroom. - Report on the use of hydroponics as a solution to growing crops under adverse climate conditions or as a means of increasing world-wide food production.

Resources

Books

Carson, Rachel. Silent Spring. New York: Haughton Mifflin, 1962.

Halpin, Anne. Organic Gardener's Complete Guide to Vegetables and Fruits. New York: Rodale Press, 1982.

Haynes, Nancy L. Biological Science: An Ecological Approach. Chicago, Ill.: Rand McNally, 1973: 216-228.

Valentine, K.W.G. and others. The Soil Landscapes of British Columbia. Victoria: B.C. Ministry of Environment, 1978.

Pamphlets (free)

Agriculture Canada.

- Acid Soils and Agriculture Liming.
- Composting.
- Management of Saline Soils.
- Manures and Composting.
- What You Should Know About Fertilizers.
- What You Should Know About Soils.

B.C. Ministry of Agriculture.

- Be Sure of the Need for Micronutrients.
- Boron.
- Fertilizer Guides (various regions e.g. Peace River, Lower Mainland).
- Green Manuring Crops.
- Peat and Muck Soils.
- Soil Notes (various topics).
- Soil pH.

PHYSICS

ASTRONOMY

Topics

The Planets and the Sun
The Astronomer's Instruments
Stars and Galaxies

Purpose

Students will learn about the structure, size and membership of the solar system and our galaxy, the development of ideas about the universe and the major concepts of how life began.

Required Background

The units on Energy and Waves should probably be completed before beginning this unit.

Key Ideas

- The positions and motions of the earth, moon and sun cause day and night, the seasons, the moon's phases, ocean tides and eclipses.
- Although the main features of the solar system have been known for some time, recent space probes have added new information about its members.
- Modern theories, while not yet complete, can describe the origin of the solar system and formation of the earth.
- Telescopes and spectrographs are the instruments commonly used to collect and analyze starlight.
- The formation, continuance and ending of stars can be explained and studied.
- Recent work in astronomy has determined the size and shape of our galaxy, who our galactic neighbours are, and the nature of pulsars, quasars and black holes.

LEARNING OBJECTIVES

1. Explain how the sun produces light and other members of the solar system are visible by reflected light.
2. Draw a diagram of the earth and sun to show that the rotation of the earth on its axis produces day and night.
3. Define the ecliptic and describe the inclination of the earth rotational axis to the ecliptic that produces our seasons.
4. Describe the motion of the moon about the earth and the production of tides and the moon's phases.
5. Describe the orbits and properties of the members of the solar system.
6. Describe the origin of the solar system.
7. State the major processes that have taken place on the earth since its formation.
8. State the principles and purposes of a telescope.
9. State the principles and purposes of a spectrograph.

LEARNING ACTIVITIES

- Observe the phases and surface of the moon with binoculars.
- Observe the surface of the sun with an inexpensive protective filter.
- Observe the planets using star charts and monthly planetary positions in the RASC Observer's Handbook.
- Construct models demonstrating day and night and the seasosn.
- Construct accurate scale models of the solar system and our galaxy.
- Locate back issues of Scientific American and National Geographic that contain photos of planetary surfaces.
- Investigate the origin of the Northern Lights.
- Investigate the origin of sun spots.
- Investigate the origin of "twinkling" in a star.
- Visit a planetarium.
- Attend a telescope viewing session given by a local astronomer or college or university teacher.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
10. State how a star holds together and produces light.	
11. Describe the formation, continuance and ending of a typical star.	
12. Describe our galaxy's size, membership and neighbours.	
13. Describe the characteristics of a pulsar, a quasar and a black hole.	

Resources

Text

Heimler and Neal. Principles of Science: Book 2, Unit 3.

Other Books

The Observer's Handbook, published annually by the Royal Astronomical Society of Canada, 124 Merton St., Toronto, Ontario M4S 2Z2.

Rogers, Eric M. Physics for the Inquiring Mind. Princeton, N.J.: Princeton University Press, 1960.

Wyatt, Stanley P., and James B. Kaler. Principles of Astronomy: A Short Version. Rockleigh, N.J.: Allyn and Bacon, 1981.

Periodicals

Astronomy.
Sky and Telescope.

ELECTRIC CIRCUITS

Topics

Voltage, Current and Resistance
D.C. and A.C. Curcuits

Purpose

This unit introduces the basics of electricity, in particular the process that takes place in simple electric circuits, the meaning of concepts like voltage, current, resistance, conductor and insulator; the reason electrical connections are made as they are; the purpose of protective devices and some characteristics of diodes and capacitors.

Required Background

The two fundamental units on Skills and Processes of Science, and Properties of Materials should be completed before starting this unit.

Key Ideas

- Electric circuits are a means of transporting energy from a source to a device.
- The source converts mechanical or chemical energy to electric energy: the device converts electric energy to a wide variety of other energy forms that include heat, light, sound and mechanical energy.

- Voltage and current are basic electrical terms that are used to describe the operating conditions of circuit components.
- Ohm's Law summarizes the relationship between voltage, current, and resistance.
- Voltage, current and resistors are measured with meters.
- Some electric circuits use direct current while others use alternating current.
- Switches, circuit breakers and fuses are used to ensure safe and controlled use of electricity.

LEARNING OBJECTIVES

1. Describe the macroscopic processes in electric circuits when they are: operating. These are electric energy being supplied by a source, conducted (transported or moved) in the wires to some device, and the conversion of electrical energy to some other energy form (light, heat, sound etc.).
2. Locate power sources. The source may be hidden behind a wall outlet or may be far away. Sources include generators (or alternators) and batteries. Sources are characterised by their voltage and whether DC or AC.
3. List some electrical devices or appliances, what they do and what operating conditions must be satisfied for proper operation.
4. Locate, in a circuit, the connecting wires between the source and the device and demonstrate that it is a loop.
5. Describe a microscopic view of a DC circuit that has a large number of indestructable electrons that move through the wire, delivering energy from the source to the device and returning to the source.

LEARNING ACTIVITIES

- Construct circuits with various sources, devices, wires and switches to make an operating circuit.
- Examine operating circuits to determine the relationship of the components.
- Study wiring diagnosis in an automobile service manual to determine the relationship of the components.
- List different voltage sources, their voltage and if DC or AC.
- Construct a voltaic cell with two dissimitar metals and an electrolyte.
- List different electrical devices or appliances with their operating conditions.
- Measure voltage and current in operating circuits.
- Determine the resistance of samples of common material.
- Verify that the current decreases and the voltage across each device decreases as more devices are connected together in series.
- Verify the voltage/current relationships in parallel circuits.
- List reasons for choosing DC or AC for voltage sources in a variety of situations.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
6. Define the current at any point in the circuit as the number or electrons that pass that point in a second. The size of the current does not depend on the energy of the electrons. The unit of current is the ampere and is measured with an ammeter.	- Inspect a circuit breaker panel and the fuses in a car to determine if the breaker has thrown or the fuse has blown. - Reset circuit breakers and replace fuses. - List a number of accepted safety practices and state why they should be followed.
7. Explain that the source provides energy to the electrons and electrical devices remove energy from the electrons. The amount loaded or removed is determined by comparing the departing electrons with incoming electrons. The energy difference per electron is measured in volts and is called voltage. It is measured with a voltmeter.	
8. State that, in a circuit containing a source and an electric device, the voltage across the source and the voltage across the device is the same. The magnitude of the voltage is determined by the nature of the source.	
9. State that, in this circuit, the current at every point is the same. The magnitude of the current depends on the nature of the device and the voltage of the source.	

ADDITIONAL LEARNING OBJECTIVES

10. Plot the voltage across a circuit device against the current through the device as different voltage sources are connected to the circuit.

11. Define resistance as the slope of line on a graph when voltage is directly proportional to current.

12. Measure resistance in ohms and understand that it may be varied by changing the composition, size or temperature of a material.

13. Define an electrical insulator as a material that has a very high resistance, used to prevent electric current from returning to the source via an undesired pathway.

14. Define an electric conductor as a material with a very low resistance, used to direct the current path in circuits.

15. State that when two (or more) resistors are connected in series with a voltage source, the sum of the voltage drops across each resistor is equal to the source current. The magnitude of the current is determined by using this result and Ohm's Law for each resistor.

16. Explain that series circuits are not commonly used because the current in the circuit and the voltage across each device depends on the number of devices in the circuit.

17. Explain that, in a circuit with a voltage source and two resistors in parallel, the voltage across each is the source voltage and the current through each is the current as if no other devices are in the circuit. As a result in parallel circuits are commonly used.

18. Explain that alternating voltage sources produce alternating currents. These currents usually go back and forth in the wire many times per second. The results from DC circuits can be used in AC circuits.

19. Describe why fuses, circuit breakers and main switches are conencted in series with the remainder of the circuit in household wiring. The lights, heaters and outlets are

connected in parallel. Fuses and circuit breakers protect against too large a current for the wires. Main switches permit repairs of or changes to existing circuits.

20. Explain that the basis of electrical safety is not to become a path for current. The use of a third wire (a ground wire) is to provide an alternate pathway for current to return to the source in the case of a device malfunction.

21. Describe the voltage/ current relationship for a device and its use in AC-to-DC conversion.

22. Describe the time-dependent voltage/current relationship of a capacitor in a DC circuit. A capacitor can store electric energy and release it later. This property is used in AC-to-DC conversion.

Resources

Texts

Heimler and Price. Focus on Physical Science, Chapters 20 and 21.

Other Books

Bolton, W. Patterns in Physics. New York: McGraw-Hill, 1974, Unit 10.

Harris, N.C., and E.M. Hemmerling. Introductory Applied Physics. New York: McGraw-Hill, 1972, Chapters 25 and 26.

Heath, Robert W., and others. Fundamentals of Physics. Toronto: Heath Canada, 1978, Chapters 11 and 12.

Miller, F., and others. Concepts in Physics. San Diego, Calif.: Academic Press, 1980, Chapters 15-17.

Read, A.J. Physics: A Descriptive Analysis. Addison-Wesley, 1970, Chapter 8.

Rogers, E.M. Physics for the Inquiring Mind. Princeton, N.J.: Princeton University Press, 1960, Chapter 32.

ENERGY

Topics

Energy of Motion and Potential Energy
Heat Energy
Electrical Energy
Energy Conservation

Purpose

Students will learn how to compute the energies involved in mechanical, thermal and electical phenomena. Two meanings of "energy conservation" will be examined: the concept of permanence and the concept of wise use.

Required Background

The units on Machines and Electric Circuits should be completed before this unit is begun.

Key Ideas

- When a force is large enough to make an object move, the work done on the mass often becomes apparent as a change in speed or a change in height.

- When the heat energy of an object changes, the temperature of the object often changes; these changes are related by the mass and specific heat of the object.

- Mechanical energy is easily and efficiently converted to heat energy, but the conversion of heat energy to mechanical energy is more difficult and less efficient.

- Power is the rate of energy conversion.

- Electrical power is computed by using the voltage and current associated with an electrical component.

- Electrical energy is calculated from the power of a component and the period of its operation.

- The widespread use of electrical energy results, in part, from the ease of its conversion into other forms of energy such as magnetic, heat and mechanical energy, light and sound.

- The scientific law of the conservation of energy means that energy is never used up. Energy can only be converted to another form. The sun, with its nuclear conversions, provides us with most of our energy which can be traced through complex processes such as photosynthesis and weather.

- The popular meaning of "energy conservation" is the appropriate use of various forms of energy. The appropriateness may be based on the supply of the energy and/or its price and/or the environmental effects produced by its use.

LEARNING OBJECTIVES

1. Compute the change in kinetic energy of an object when the mass and change in speed of the object is given.
2. Compute the change in potential energy of an object given its mass and change in height.
3. Compute the work done when the applied force and the distance it is applied through are given.
4. Use the law of conservation of energy: the work done equals the change in potential energy plus the change in kinetic energy.
5. Use the law of conservation of energy when energy associated with frictional forces are present.
6. Compute the energy required to change the termperature of an object, given the mass and specific heat of the object and the temperature change.
7. Compute the energy required to change the phase of a substance given the latent heat of the phase change of the substance and the mass of the substance.

LEARNING ACTIVITIES

- Measure the energy and power available from people and compare to electric motors.
- Convert horsepower to watts for a number of engines.
- Read electric and gas meters.
- Compute the cost of natural gas or electricity.
- Compare the cost of providing electricity by a generator or by B.C. Hydro.
- Study the operation of fuel cells and wind generators.
- Study the history of the word conservation.
- Study various energy conservation practices.
- List various practices that do not conserve energy.
- Compute the energy costs of various forms of transportation and space heating.

ADDITIONAL LEARNING OBJECTIVES

8. Explain the conversion of mechanical energy into heat energy via frictional forces.

9. Explain the conversion of heat energy into mechanical energy and the efficiency of the processes.

10. Compute the power in an energy transformation, given the energy converted and the time required for the conversion.

11. Compute the electrical power supplied to a device given the voltage and current.

12. Compute the electrical energy given the power and the time.

13. List different energy types such as light, magnetic energy or sound and explain how they can be produced.

14. Define a second meaning of energy conservation as an increase in the ratio, "energy out divided by energy in" for a given process.

Resources

Texts

Heimler and Neal. *Principles of Science: Book 1*, Chapter 3.

__________. *Principles of Science: Book 2*, Chapter 22.

Heimler and Price. *Focus on Physical Science*, Unit 6.

Other Books

Bolton, W. *Patterns in Physics*. New York: McGraw-Hill, 1974, Unit 3.

Fowler, J.M. *Energy and the Environment*. New York: McGraw-Hill, 1975.

Heath, Robert W., and others. *Fundamentals of Physics*. Toronto: Heath Canada, 1981, Chapters 8 and 9.

Rogers, E.M. *Physics for the Inquiring Mind*. Princeton, N.J.: Princeton University Press, 1960, Chapters 26-29.

SIMPLE MACHINES

Topics

Simple Machines: levers, pulleys, gears, ramps and hydraulic cylinders

Combinations of Simple Machines

Purpose

Many common machines can be considered as an engine and an organized collection of levers, gears and hydraulic equipment. Students will gain an understanding of how machines are organized to do work.

Required Background

Completion of the fundamental unit on Properties of Materials and Atomic Structure.

Key Ideas

- A machine or tool consists of two essential parts - one that requires a fuel to produce a force or pressure and a second part that matches this force or pressure, to the purpose of the machine.
- The force-producing part of the machine may be a person, an electric motor, or a gas or diesel engine.

- The force-matching part of the machine may be a combination of levers, gears or hydraulic cylinders that alter the direction, magnitude or speed of the initial force or pressure.

- Friction reduces the effectiveness of machines and wears out parts.

- Machines must be designed for the forces they are expected to apply.

- The ramp and pulley are other devices that may be called simple machines.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
1. For each of various common tools or machines such as a screwdriver, backhoe, forearm and chainsaw, identify its purpose, force-producing and force-matching part. 2. Characterize the force-producing part of these machines by type of fuel (e.g. food, gas, electricity) and by the type of force (e.g. straight line or circular, large or small, fast or slow). 3. Examine the reliability, convenience, portability, noise and exhaust for various types of force originators. 4. Characterize the force-matching part of various machines by the type of force or by the pressurized fluid it accepts, and by the type of force it delivers. 5. Identify the input force distance and the output force distance for any lever. 6. Calculate, using the appropriate formula, the output force at balance given the input force and necessary dimensions of a lever.	- List a number of machines and locate and describe the force-producing part and the force-matching part. - Discuss the implications if one type of force-producing part is substituted for others. For example a human-powered crosscut saw, a gas chainsaw, an electric chainsaw or a tree snipper. - Identify the levers and hydraulic cylinders on a backhoe. - Identify the levers and determine the steps in the operation of a Jack-all jack. - Verify the force/distance relationships for a lever, a ramp or a windlass. - Investigate the effects of using levers of decreasing strength to lift a standard load. - Study simple structures (for example a beam that supports a single heavy load) to determine that beams are "levers in disguise". - Describe how a transmission works. - Design a hydraulic system to supply a given force at a given speed.

ADDITIONAL LEARNING OBJECTIVES

- Explain that the lever and support for the fulcrum must be strong enough to transfer forces without failure: yet its design is influenced by other factors such as weight and cost.
- Explain that not all supplied forces are transferred to useful output forces; that friction involves forces that produce heat and wear, and that lubrication and bearings may minimize these effects.
- Calculate, using appropriate formulas, the output force and output speed of a hydraulic piston, given the fluid pressure, the fluid flow rate and cylinder dimensions.
- Calculate the force necessary to lift a load using various combinations of pulleys.
- Calculate the force necessary to slide a load up a frictionless inclined plane, given the dimensions of the ramp.
- Calculate the force necessary to lift a load on a windlass, given the dimensions of the windlass.
- Calculate the speed of an output gear, given the input gear speed and the sizes of the gears.

Resources

Texts

Heimler and Neal. *Principles of Physical Science: Book 1*, Chapter 7.

Heimler and Price. *Focus on Physical Science*, Chapter 2.

Other Books

Andrews, William A., and others. *Discovering Physical Science*. Scarborough, Ont.: Prentice-Hall Canada, 1982, Chapter 24.

Harris, N.C., and E.M. Hemmerling. *Introductory Applied Physics*. New York: McGraw-Hill, 1972, Chapter 6.

Marshall, J.S., and others. *Physics*. New York: St. Martin's Press, 1967, Chapter 7.

WAVES

Topics

Waves in One Direction
Water and Sound Waves
Light and Electromagnetic Radiation

Purpose

This unit deals with the basic properties of waves, with some differences between types of waves and the usefulness of waves in our world.

Required Background

The fundamental unit on Properties of Materials should first be completed.

Key Ideas:

- Properties of waves include amplitude, wave speed and frequency.
- Absorption, reflection, refraction, diffraction and interference occur when waves interact with their surroundings.
- Light and sound are common examples of waves.
- Waves are used for purposes such as communication and remote sensing of otherwise inaccessible areas.

LEARNING OBJECTIVES

1. Define amplitude of a wave.
2. Define wave speed.
3. Explain the factors which determine wave speed.
4. Explain that when motion of the wave source is regular, the frequency of the wave is the same as that of the source.
5. Define wavelength and period of a wave.
6. Use the formula "wave velocity equals the product of wave length and frequency" in a variety of problems.
7. Describe the microscopic motions in a compressional wave and a transverse wave.
8. Define and give examples of the absorption of waves.
9. Define and give examples of the reflection of waves.
10. Define and give examples of the refraction of waves.
11. Define and give examples of the diffraction and interference of waves.

LEARNING ACITVITIES

- Examine the wave properties of a stretched rope or a rope hanging from a tall building.
- Vary the mass per unit length of a rope and observe changes in wave behaviour.
- Using a long solid (a piece of railway track), estimate the speed of a sound wave.
- List possible examples of one dimensional waves - pipelines, rivers or narrow inlets for example.
- Use a ripple tank to observe absorption, reflection, refraction, diffraction and interference.
- Observe the wave patterns from a high bridge over a busy shipping channel.
- Observe the wave patterns from an object like a canoe puddle moving slowly through still water.
- Examine the components of a speaker and a microphone.
- Study the operation of the ear and larynx.
- Study the production of tones from a musical instrument.

LEARNING OBJECTIVES	LEARNING ACITVITIES
12. Describe the operation of speakers and microphones. 13. Explain that pitch of a sound is related to the wave frequency. 14. State the range infrequency of normal human hearing. 15. Explain that loudness is related to the amplitude of the wave. 16. Describe the meaning of the loudness scale and how hearing damage can be prevented. 17. State the major bands in the electromagnetic spectrum. 18. Explain that electromagnetic radiation act like waves. 19. Describe examples of applications of the wave properties of electromagnetic radiation. 20. Describe some differences in the different frequency bands that account for different uses. 21. Draw ray diagrams for the reflection and refraction of light.	- Determine the operating principles of ultrasonic diagnostic and treatment equipment. - Reseach the formation and effects of sonic booms. - Investigate how a seismograph operates. - Investigate the operation of a variety of electromagnetic radiation sources and detectors (including lights of different types, antennas, x-ray sources, film, eyes, microwave ovens, and radar). - Use a diffraction grating to view different types of light. - Investigate the propagation of different types of waves through human tissues.

LEARNING OBJECTIVES

22. Describe what is meant by an image.
23. Draw the ray diagrams for a convex and concave lens.
24. Describe the behaviour of white light incident on a prism.
25. Explain how light can also act as a particle under some circumstances.

LEARNING ACITVITIES

- Investigate the different communication methods using electromagnetic radiation - AM FM and pulse coded modulation.
- Observe reflection refraction, diffraction and interference of light.
- Compare the angular separation of two objects using unaided vision and binoculars.
- Draw ray diagrams for simple telescope and microscopes.
- Find out about and report on different types of vision defects.

Resources

Texts

Heimler and Neal. *Principles of Science: Book 1*, Chapter 4.

__________. *Principles of Science: Book 2*, Chapter 19.

Heimler and Price. *Focus on Physical Science*, Unit 5.

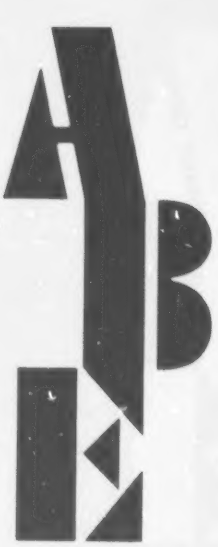
Other Books

Bolton, W. *Patterns in Physics*. New York: McGraw-Hill, 1974, Unit 6.

Harris, N.C., and E.M. Hemmerling. *Introductory Applied Physics*. New York: McGraw-Hill, 1972, Chapters 25 and 26.

Heath, R.W., and others. *Fundamentals of Physics*. Toronot: Heath Canada, 1978, Chapters 11 and 12.

Rogers, E.M. *Physics for the Inquiring Mind*. Princeton, N.J.: Princeton University Press, 1960, Chapter 10.



DEFINITION, EXPLANATION, AND INDEX OF UNITS

Definition

Advanced units are those generally requiring some previous science background and are often designed to follow intermediate units. They are divided into General, Biology, Chemistry, Physics, and Earth Science groups.

Explanation

Each sample unit contains information listed under these headings:

Topics,
Purpose (of the unit),
Required Background,
Key Ideas,
Sample Learning Objectives,
Learning Activities,
Resource.

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GENERAL SCIENCE

CONTEMPORARY ISSUES IN SCIENCE

Topics

One topic selected by the student in consultation with the instructor. Possible topics include:

Life Beyond Earth (extra-terrestial beings)
What is Life? (abortion, euthanasia)
Creation vs Evolution
Environmental Responsibility
Life in the Nuclear Age (nuclear power, nuclear disarmament)
Population Explosion
The New Technology (computers, video teaching and games, microwaves, etc.)
Controlled environments ("bubble towns", new trends in housing, etc.)
Land Use (industry vs agriculture, hydro development)
Increased Importance of Leisure
Biotechnology
Genetic Engineering
Ethical Aspects of Bio-Engineering
Biological Warfare
Chemical spraying

Purpose

In their roles as workers, family members, citizens and voters, adults continually come into contact with contemporary issues related to science. Frequently, they find themselves having to make decisions on these issues which will directly affect their own lives, as well as those of others. This unit provides an opportunity to study a contemporary issue in some depth, with emphasis on its scientific background.

Required Background

The unit is probably best done after a number of advanced units are completed, including one directly related to an issue.

Key Ideas

o Scientific knowledge may provide essential background understanding of issues affecting one's life.

o Scientific knowledge may improve the soundness of personal or community decisions.

Learning Activities

- The topic may be selected from the suggestions above or may be another of local, current or personal interest. It does not have to be controversial. However, if it is controversial the student should state both sides of the issue and give scientifically-backed reasoning for a particular position.

- Any report should be based upon personal research such as interviews or field observations, as well as library research and should include a complete bibliography. Tables, graphs and illustrations should be used where applicable. Additional credit in the English/Communications course might be arranged.

Resources

See items listed in intermediate Science and Technology unit.

BIOLOGY

BODY SYSTEMS 1: MOVEMENT AND CONTROL

Topics

Muscular System
Skeletal System
Nervous System
Senses
Hormones

Purpose

This is the first of the advanced human biology units. It focuses on the structure of the human body and the systems by which the body monitors the external and internal environment, thus sustaining life.

Required Background

The intermediate unit on The Cell or equivalent knowledge.

Key Ideas

- In the human body there is a remarkable interdependence between the muscular and skeletal systems.

- Despite this interdependence, each of the two systems is unique and highly specialized.

- The nervous system, the senses and the hormones allow the human body to respond to external and internal environment. Although each is highly specialized for one particular function, any one system could not function properly without the interrelationship with other body systems.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
1. Discuss the structure and function of the following: skeletal system, bones, joints, ligaments, tendons, red marrow and yellow marrow. 2. Name and describe the types of muscle and their functions. 3. Discuss the microscopic structure and physiology of skeletal muscle contraction. 4. Describe the chemistry of muscle contraction. 5. Name and describe some common disorders of muscles and bones. 6. Name the various parts of the nervous system and the particular action of each division. 7. Describe the structure and function of the three major types of neurons. 8. Name several neurohormones and describe the structure of a synapse. 9. Distinguish between a simple reflex and a conditioned response. 10. Describe the autonomic nervous system and cite similarities as well as differences in the structure and function of the two divisions (sympathetic and parasympathetic).	- Relate the different components of the skeletal system to the different functions with the aid of charts, diagrams, models or a skeleton. - Identify the three types of muscle and state the characteristics of each. - Compare longitudinal and cross-sectional slides of muscle, relating the cytology to the function, e.g. contraction. - Compare and contrast the structure of bone, tendon, ligament and cartilage as viewed on microscopic slides. - Compile a list of common muscle and bone ailments or discomforts. - Use diagrams or charts to identify the three major types of neurons (sensory, motor, association) and describe the function of each. - List several neurohormones and label or identify the main parts of a synapse. - Prepare a list of differences between the sympathetic and parasympathetic systems and explain how these relate to overall body function.

LEARNING OBJECTIVES

11. Name the five sense receptors found in the skin, and describe the location, structure, mechanism of action for each.

12. Describe the anatomy of the eye and the ear and discuss the function of each.

13. Describe the sense receptors for balance and hearing.

14. Discuss the transport, production, and physiological action of the major hormones.

15. Cite the anatomical location and describe the interrelationships of the major endocrine glands.

16. State various examples of feedback control.

17. Name and describe known illnesses associated with the major endocrine glands.

18. Describe how hormones and the nervous system work in conjunction to maintain a balanced internal environment.

LEARNING ACTIVITIES

- Identify the different skin receptors and describe their role or function. Use diagrams or models.
- Look at models or diagrams of the eye and the ear to identify the major parts by their correct names, and discuss their function.
- Differentiate between a ductless gland and a ducted gland. Discuss the importance of each.
- Identify the location of each gland on a prepared diagram of the human body.
- State which gland may be malfunctioning, given a list of known diseases related to the endocrine system.
- Describe blood pressure and flow regulation, kidney function and body water and electrolyte balance, hormonal regulations of menstruation, etc.

INTEGRATION WITH OTHER AREAS OF ADULT INTEREST

The instructor may also wish to use the study of human biology as an opportunity to relate and integrate other aspects of adult interest and concern, such as the following:

1. Appreciate the impact of technology on biomedical research.	- Do library research on the role of the "chip" in biomedical technology.
2. Develop a deeper understanding for the complexity and fragility of the nervous system.	- Read about interesting aspects of the nervous system e.g. acupuncture, biofeedback.
3. Appreciate the importance the human senses and the role of technology in extending them.	- Determine the effect of robots on society, through research in science magazines.
4. Investigate how the nervous system adjusts itself to sensory loss e.g. compensation and sensory extension.	- Investigate some technological advances which extend the senses or the nervous system.
	- Investigate the effects of mood altering drugs.
	- Investigate the effects of loud sound (e.g. music, industrial noise) on the nerve sensors in the ear.

Resources

Texts

B.C. Ministry of Education. VAST 4 Biology. Unit 4, Topic F.

Heimler. Focus on Life Science. Unit 4, Ch. 1 and 3.

Heimler and Neal. Principles of Science: Book 2. Unit 1, Ch. 2 and 5.

Other Books

Berry, Gordon S., and Harold P. Gopaul. Biology of Ourselves: A Study of Human Biology. Rexdale, Ont.: Wiley, 1982.

Curtis, Helena, and N. Sue Barnes. Invitation to Biology. New York: Worth, 1981.

Keeton, William. Biological Science. 3rd edition. New York: Norton, 1980.

Mader, Sylvia S. Inquiry into Life. Dubuque, Iowa: Wm. C. Brown, 1982.

Ritchie, Donald, and Robert Carola. Biology. New York: Addison-Wesley, 1979.

Periodical Articles and Films

See resources listed for intermediate biology units.

BODY SYSTEMS 2: INTERNAL PROCESSES

Topics

Digestive System
Circulatory System
Respiratory System
Excretory System

Purpose

This is the second of two human biology units. It deals with the internal processes of the body, and their interdependence.

Required Background

The intermediate unit on the Cell, and Body Systems 1, or equivalent knowledge.

Key Ideas

- The major internal body processes are the digestive, circulatory, respiratory and excretory systems.
- Although each is specialized for one particular function, no one system could function properly without the close interrelationships with other body systems.

LEARNING OBJECTIVES

1. List the six food groups and describe their basic functions in the body.
2. Label a prepared diagram of the digestive system and explain the function of each digestive organ.
3. Distinguish between physical and chemical digestion and explain the type of digestion occuring in each of the digestive organs.
4. Describe the agents of digestion and the end products in each digestive organ.
5. Explain how enzymes function according to the lock-and-key theory.
6. Discuss the absorption of food products and the use of foods in terms of body needs.
7. Describe some malfunctions of the digestive process; (ulcers, acid imbalance, enzyme deficiency).
8. Identify the two main methods for movement of fluid: the circulatory and lymphatic systems.
9. Identify the organs of circulation, the arteries, veins, capillaries, and explain their respective functions.

LEARNING ACTIVITIES

- Identify the major organs of the digestive system on a prepared diagram and explain the function of each.
- Compile a list of digestive enzymes at work in the digestive system and relate each to the chemical reactions they assist.
- Design an experiment to test how environmental conditions affect the rate of an enzymatic reaction e.g. pH, temperature, concentration.
- List the essential nutrients required for proper body functioning (e.g. amino acids, glucose, fatty acids, vitamins) and relate these to the six food groups.
- Use charts and diagrams to trace the circulatory and lymphatic systems, and to explain the purpose of each system.
- Use diagrams, charts or microscopic slides to identify and explain the function of arteries, veins and capillaries and their relationships to one another.
- Draw and label a diagram of the human heart and indicate the direction of blood flow.

LEARNING OBJECTIVES

10. Explain the functions of the blood.

11. Describe pulmonary, renal, coronary, hepatic, portal and systemic circulation and relate each to body needs.

12. List the major components of the blood and explain the function of each component.

13. Explain how the cardiac muscle controls the circulation of the blood.

14. Describe the lymph nodes and lymph vessels and explain the movement of lymph.

15. Explain some malfunctions of the circulatory and lymphatic systems with reference to varicose veins, heart attack, hypertension, tonsilitis, arteriosclerosis.

16. Define respiration in terms of the external, internal or cellular processes.

17. Diagram and explain the function of the organs of the body involved in respiration.

18. Explain the role of hemoglobin and the exchange of gases in the alveoli of the lungs and in body cells.

LEARNING ACTIVITIES

- Name the primary functions of blood (transport, clotting, and fighting infection) with an explanation of each.

- Measure functions of the circulatory system such as blood pressure, resting heart rate, recovery rate after exercise, clotting rate and level of hemoglobin.

- Determine blood type and Rh factor.

- Identify the five different types of circulation on a chart or diagram and relate each to the needs of the body.

- Research an abnormality or defect of the circulatory or lymphatic systems.

- Identify and describe given situations as examples of external, internal or cellular respiration.

- Use prepared diagrams or charts to identify and explain the function of the major organs in the respiratory system.

- Trace the path taken by air entering the body and describe how hemoglobin is suited to its role as a respiratory pigment.

LEARNING OBJECTIVES

19. Explain the need for gas exchange in body cells with respect to respiration at the cellular level.

20. Name and describe several disorders of the respiratory system that may impair the overall health of the individual e.g. emphysema, cancer, pneumonia.

21. Name the excretory wastes and relate them to the end product of metabolism and the organ of excretion (i.e. kidney, liver lungs, skin, large intestine).

22. Trace the path of urine, and describe in general terms the function of each organ involved.

23. Describe the three steps in urine formation (filtration, selective reabsorption and secretion) and relate these to parts of the nephron.

24. State how water excretion and blood pH are regulated by the kidney.

25. Describe the path of blood about the nephron.

26. Explain common malfunctions of the urinary system and name three symptoms indicating kidney failure.

LEARNING ACTIVITIES

- Identify the cause and explain the effects of given respiratory disorders.

- State the correct function or role of given excretory organs.

- Use a prepared diagram or model to illustrate the path of urine and explain the function of the major organs.

- Relate the steps in urine formation to a prepared diagram of the nephron.

- Define the term "homeostasis" and relate it to the function of the kidneys.

- Illustrate the path of blood around a nephron using a prepared diagram.

- Compile a list of symptoms indicating possible kidney malfunction and then investigate the possible causes of these symptoms.

INTEGRATION WITH OTHER AREAS OF ADULT INTEREST

The instructor may also wish to use this unit to relate and integrate other aspects of adult interest and concern, such as the following:

1. Appreciate good nutrition its relationship to common diets, and the availability of nutritious foods.
2. Appreciate the role of medical technology in allowing some individuals an extension of life (e.g. pacemakers, drugs, machinery to assist surgery).
3. Evaluate the advances of medical technology on society in terms of cost, benefits and population growth.
4. Predict the effects of various forms of environmental pollution on the respiratory system.
5. Appreciate how one's lifestyle affects the respiratory system, circulatory system, and excretory system.
6. Appreciate the role of technology in the development of artificial kidneys and other organs.

- Invite or interview a doctor interested in holistic medicine, to discuss the relationship between lifestyle, eating habits and good health.
- Research some advances in medical technology and how these relate to the circulatory system and their effects on the individual and society.
- Do a library search on various types of air pollution and how they affect the respiratory system.
- Evaluate individual lifestyle in terms of improving the functioning of the respiratory and circulatory systems.
- Research the effects of poor diet or lifestyle on the excretory system and future prospects for people suffering from severe kidney damage.
- Research the effects of cigarette smoking on heart and lungs.

Resources

Texts

B.C. Ministry of Education. VAST 4 Biology. Unit 4, Topics A-E.

Heimler. Focus on Life Science. Unit 4, Ch. 2 and 4.

Heimler and Neal. Principles of Science: Book 2. Unit 1, Ch. 3 and 4.

Other Books

See advanced unit Body Systems 1.

Periodical Articles and Films

See resources listed for intermediate biology units.

HUMAN GROWTH AND REPRODUCTION

Topics

Mitosis and Meiosis
Human Reproductive Systems
Human Growth and Development

Purpose

This is a human biology unit, adaptable to students with general interests or those planning careers in the health specialties. It deals with the processes of mitosis and meiosis, an understanding of the human reproductive system, and the process of fertilization and embryo development.

Required Background

None.

Key Ideas

- Hormones control the reproductive process and the sex characteristics of the individual.
- Human reproduction is one of the most highly specialized forms of sexual reproduction.
- Reproduction is directly related to the survival of the species.

LEARNING OBJECTIVES

1. Explain the process of cellular reproduction by means of mitosis and meiosis.
2. Describe the purposes of cell division.
3. Relate the process of meiosis to the production of egg (oogenesis) and sperm cells (spermatogenesis).
4. Relate cell division to the biology of aging.
5. Name the particular endocrine glands and hormones important to male and female sexual reproduction.
6. Name and label the parts of the male and female reproductive systems and state the function of each.
7. Describe the menstrual cycle in general terms.
8. Describe the composition of semen and the glands that contribute to its production.
9. Explain fertilization in terms of hormonal change, germ layers and zygote development.
10. Describe in general terms the development of the human fetus.

LEARNING ACTIVITIES

- Look at cell models and explain the changes that occur in the surface-to-volume ratio as a cell grows and hence the reason for cell division.
- Illustrate the differences between mitosis and meiosis by means of a simple diagram, model or poster.
- Use a diagram or model to study and identify the major parts of the male and female reproductive systems.
- Describe the importance and main stages of the menstrual cycle.
- Use diagrams, overheads or models to illustrate the stages of development from fertilized egg to embryo.
- List the main stages in the development of a human fetus.
- Do library research about sexually transmitted diseases and their effects on individuals and society.
- Do library research on the advances made in the field of in vitro fertilization.
- Investigate recent developments in genetic engineering.
- Investigate the biological basis of aging.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
11. State five methods of birth control and the effectiveness of each.	- Research the effect on fetal development of drugs taken by the mother.
12. Name some well-known sexually transmitted diseases and explain their effects on the individual and in society.	

INTEGRATION WITH OTHER AREAS OF ADULT INTEREST

The instructor may also find opportunities to relate and integrate other aspects of adult interest and concern, such as the following:

1. Appreciate the cause and effect relationships between overpopulation and the environment.
2. Evaluate the effect of an increase or decrease in human fertility on the survival of the species. What are the factors that affect human fertility?
3. Weigh the advantages and disadvantages of in vitro fertilization to individuals and society.
4. Evaluate the merits and dangers of 'genetic engineering'.

Resources

Books

See resources listed under advanced unit Body Systems 1.

Periodical Articles and Films

See resources listed under intermediate unit Human Behaviour and Development.

HUMAN INHERITANCE

Topics

Mendelian Genetics
Modern Theory of Genetics and the Hardy - Weinberg Law
Human Genetic Diseases

Purpose

The purpose of this unit is to familiarize students with the factors responsible for heredity such as genes, chromosomes, and DNA. The unit deals with Mendel's Laws and how these may be applied to solve simple genetic crosses involving one trait, two traits or sex-linked traits. Learners will study the Modern Theory of Inheritance and apply factors unknown to Mendel (gene inheritance, mutations, non-disjunction, linkage and multiple alleles) to solve genetic problems. Also studied will be common human genetic disorders, their causes and effects.

Required Background

Study of cellular or human reproduction such as the intermediate unit on Human Development and Behaviour or equivalent knowledge.

Key Ideas

- Genes are the fundamental units of inheritance and are composed of DNA.
- The principles of genetics are the same for humans as they are for other species.
- Mutations are the source of new genetic characteristics upon which evolution depends.
- Human genetic diseases may result from environmental or inherited factors which affect the chromosomal DNA.

LEARNING OBJECTIVES

1. Describe the structure of a nucleotide.
2. Explain and describe the ladder and helical structure of DNA.
3. Describe the process of DNA replication and discuss its significance.
4. Describe the manner in which hereditary traits are transferred from parent to offspring.
5. Explain how some inherited traits can be dominant, recessive or blended.
6. Solve problems involving one-trait or two-trait characteristics including those involving incomplete dominance.
7. Predict the results of problems involving linked genes when crossing over does not occur.
8. Read and interpret a pedigree.
9. State and describe common errors in chromosomal inheritance.
10. Categorize mutations according to their cause.
11. State examples of some inborn metabolic defects in humans.

LEARNING ACTIVITIES

- Study charts or diagrams showing the molecular structure of a DNA molecule.
- Construct a model of a DNA molecule (i.e. pop-beads) and show DNA duplication [Carolina Biological Supply has good instructional sets].
- Review meioses.
- Construct a family tree for certain single gene factors such as the ability to roll the tongue, shape of ear lobes, and spans, widows peak, hand folding, etc. Discuss the presence of dominant recessive or blended traits in family tree.
- Work out problems involving sex-linkage, multiple gene inheritance, carriers, blending inheritance etc.
- Examine a pedigree and determine if a trait is dominant, recessive or sex-linked.
- Investigate such diseases as cystic fibrosis, sickle cell anemia, Huntington's disease and Down's syndrome.
- List examples of mutations resulting from chromosomal, gene, environmental, germal and somatic abnormalities.
- Investigate the cause of albinism, phenylkentonuria, and Tay-Sachs disease.

Resources

Books

See resources listed for advanced unit Body Systems 1.

Periodical Articles

SciQuest articles, including the following:

Feb 1980 - Recent genetic discoveries - mother's milk and formulas are tested.

July/Aug 1980 - Inborn errors in metabolism can sometimes be corrected if discovered early.

Jan 1981 - DNA repair mechanisms correct damage from mutagens.

March 1981 - What does an extra bit of DNA do?

July/Aug 1981 - Summary of bioengineering developments.

Films

The Differences are Inherited
27:50 CBC: Nature of Things Col 106C 1076 064

David Suzuki uses the example of the fruit-fly to discuss mutations, current genetic research and the relationship of this research to human problems.

DNA
10:40 NFB Col 106C 0168 174

The genetic material is described and illustrated by colour animation. Mutations are also discussed.

PLANT SYSTEMS AND FUNCTIONS

Topics

Plant Structures and Functions
Photosynthesis
Vascular and Non-Vascular Plants

Purpose

All living organisms must carry out a number of basic life functions. The key role of plants as the basic producers of food is best understood when their structures and functions are compared and contrasted with those of animals. This unit will be especially useful to students entering forestry, agriculture or other biologically oriented careers.

Required Background

A fundamental knowledge of plant and animal cells and their structure and of mitosis and meiosis; some basic chemistry and knowledge of the diversity of plant forms.

Key Ideas

- Plants are both similar to and different from animals in both cellular structure and systemic organization.
- A living plant functions as the sum total of the various systems which comprise it.
- Photosynthesis is the key process which provides energy for all living things.
- Simple, non-vascular plants have analogous structures to those of higher plants.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
1. Draw or label a diagram of a typical plant cell and explain three ways in which it may differ from an animal cell.	- Study prepared microscope slides, wall charts or textbook diagrams of plant and animal cells.
2. Name the major parts of a typical vascular plant (root, stem, leaves, flowers).	- Make drawings of the parts of a typical plant from a living specimen. - Collect a number of wild or garden plants and classify by root type.
3. List 3 major functions of roots.	- Decide what function these roots have.
4. Describe the differences between tap and fibrous roots and name 3 plants with each root type.	- Cut a carrot crosswise and length-wise and identify the parts.
5. Identify the parts of a tap-root visible to the naked eye in cross- and longitudinal sections.	- Study prepared cross-sectional diagrams or prepared slides and identify the parts.
6. State the function of the epidermis, cortex, pericycle, phloem, xylem, and pith and locate these parts on a cross-sectional diagram or prepared microscope slide.	- Make a chart of root parts and their functions. - Examine roots of sprouted radish seeds with a hand lense or low-power microscope and identify root hairs.
7. State the function of the root cap and of root hairs and indicate where each is found.	- Examine a microscope slide of a root tip and find the root cap.
8. Explain how roots take up water and transfer it to the rest of the plant.	- Encase the root of a carrot plant in plastic or paraffin wax and replant and observe the effect on the plant.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
9. Label a diagram of a cross-section of an annual dicotyledon, monocotyledon and woody stem. 10. List the basic functions of plant stems. 11. Explain how the phloem and xylem are produced in a woody stem. 12. Define primary and secondary meristems, tell what each does and where each is found. 13. Explain how bark is formed and what its function is. 14. Define and give the function of lenticels. 15. State the functions of leaves. 16. Identify the main parts of a typical broad, deciduous leaf. 17. Describe plant leaves in terms of their shape, pattern of venation and arrangement on the stem. 18. Label the upper and lower epidermis, stoma, guard cells, spongy mesophyll, palisade (mesophyll) cells, phloem and xylem on a cross-section of a leaf. Specify which cells possess chloroplasts.	- Examine microscope slides or diagrams of monocot, dicot and woody stems, draw diagrams and label them. - Compare stems of trees, vines, creeping plants, etc. and show how they are alike in function. - Label the locations of primary and secondary meristems on a plant diagram. - Show the effect of "pinching out" on the growth of a plant. - Examine, draw and label a cross-section of a tree trunk. - Locate lenticels on bark samples of cherry, birch or alder bark. - Discover what happens if all of the leaves are removed from a bean plant. - Draw a typical leaf and label. - Collect, press and mount leaves, identifying each and describing the shape, venation and arrangement on the stem. - Examine prepared microscope slides of leaf cross-sections.

LEARNING OBJECTIVES

19. Name the parts of a typical complete flower (e.g. tulip, appleblossom, bean flower).

20. Explain what the terms 'complete' 'incomplete', 'staminate' and 'pistillate' mean when used to describe flowers.

21. Distinguish between pollination and fertilization in flowers.

22. List at least five different pollinating agents and give at least one example of a plant pollinated by each.

23. Label a diagram of plant fertilization and describe, in order, the steps involved.

24. Define the terms monocotyledon, dicotyledon, angiosperm and gymnosperm and give three or four examples of each.

25. Label diagrams of typical monocot and dicot seeds and state the function of each part.

26. List at least five methods used by plants to disperse their seeds and give examples of each.

LEARNING ACTIVITIES

- Label prepared diagrams of leaf cross-section.

- Examine flowers or anatomical correct flower models and identify parts.

- Find pictures of complete, incomplete, staminate and pistillate flowers.

- Identify common plants with monoecious plants or staminate and pistillate flowers.

- Discuss the meanings of pollination and fertilization.

- Identify flowers using different methods of pollination.

- Use prepared diagrams of the process of fertilization.

- Identify economically important plants as monocots or dicots, angiosperms, or gymnosperms.

- Collect plant samples of vegetative reproduction.

- List economically important plants propagated by vegetative methods.

- Find bulbs (onion), corms (crocus), rhizomes (iris), tubers (potato). Cut one of each in half longitudinally and identify parts. Let another sprout and then examine it again.

LEARNING OBJECTIVES

27. Define the term vegetative reproduction and list at least 6 methods with examples of each.

28. Explain what a bulb, corm, rhizome and tuber are and give one or more examples of each.

29. Write the chemical equation for photosynthesis (using words or chemical formulae).

30. List the conditions necessary for photosynthesis.

31. State how each reactant in photosynthesis is obtained and what becomes of each product.

32. Compare and contrast the processes of photosynthesis and respiration in a plant.

33. List the three main elements required for plant growth and give at least one function of each.

34. Discuss trace element nutrition in plants.

35. List the major groups of vascular plants and give several examples of each.

LEARNING ACTIVITIES

- Write a balanced chemical equation for photosynthesis.
- Make a chart of the sources of reactants and uses of products of photosynthesis.
- Cover lower sides of a bean plant's leaves with vaseline and observe the result.
- Observe the effect of placing a plant in darkness.
- Compare the equations for photosynthesis and respiration.
- Examine fertilizer bags for element content. Compare "chemical" fertilizers with organic manure.
- List symptoms of nitrogen, potassium or phosphorous deficiency in plants.
- List trace elements and their importance to plants.
- Collect and identify samples of angiosperms, gymnosperms and ferns.
- Label a prepared diagram of fern and moss life cycles, stating which phases are 2N and N.
- Examine a moss plant or label a diagram of one.
- Compare the advantages of higher plant seeds over lower plant spores.

LEARNING OBJECTIVES

36. Label a diagram of a typical frond (leaf) of a fern.

37. Describe, by means of a diagram, the life cycle of a fern. Explain how this differs from that of an angiosperm.

38. Label a diagram of a typical moss plant.

39. Describe by means of a diagram the life cycle of a moss. Explain how it differs from that of a fern or an angiosperm.

40. List several non-photosynthetic plants and give several examples.

41. List the major groups of algae according to their pigmentation.

42. State the importance of phytoplankton in terms of ocean food chains.

43. List at least five different non-vascular plants of economic importance and tell how each is used.

LEARNING ACTIVITIES

- Collect and identify samples of mushrooms, other fungi and molds.
- Make spore prints of mushrooms.
- Collect samples, examine preserved specimens or diagrams of green, red, brown and blue-green algae.
- Examine prepared slides of spirogyra, diatoms and desmids.
- Examine pond water samples microscopically.
- Identify samples of or products from economically important non-vascular plants.

Resources

Texts

Heimler. Focus on Life Science: 150-207, 234-251.

Heimler and Neal. Principles of Science: Book 1: 316-339.

Other Books

Haynes, Nancy L. (Ed.). Biological Science: An Ecological Appraoch. Chicago, Ill.: Rand McNally, 1973.

Periodical Articles

Blair, John G. "Test-tube Gardens." Science '82 (Jan/Feb 1982): 71-82.

Brownlee, Shannon. "The Silent War". Discover, 4, No. 9 (September 1983), 28.

Hoover, Richard B. "Those Marvellous Diatoms." National Geographic, 155, No. 6 (June 1979): 871-878.

Lee, Donald. "Slime Mold: The Fungus that Walks." National Geographic, 160, No. 1 (July 1981): 130-136.

PLANT AND ANIMAL DISEASES

Topics

Diseases and their Causes
Transmission
Treatment
Control

Purpose

With global emphasis on increased food production and improved use of forest resources, there is a need for wider knowledge of diseases of plants and animals, including their causes, treatment, transmission and control. This unit will be particularly useful to students entering careers in agriculture, forestry or health sciences.

Required Background

Completion of the intermediate unit on Disease or equivalent knowledge: the intermediate unit on Classification and Diversity of Life would also be useful background.

Key Ideas

- Infectious diseases of plants and animals are caused by a wide variety of agents.

- The choice of treatment of plant and animal diseases depends on the effect of the disease as well as its causative agent.

- The prevention and control of the spread of these diseases may often be attained by biological means.

LEARNING OBJECTIVES

1. Classify diseases of plants and animals by type of causative agent (bacteria, virus etc.) and give an example of each.
2. List the major ways in which plant land animal diseases are transmitted from host to host. Give examples for each.
3. Describe the life cycle of several pathogens which require one or more intermediate hosts, including malaria, flukes, tapeworm.
4. Explain the phrase "prevention is the best treatment" as it applies to diseases of plants and animals.
5. List precautions lwhich should be taken in the disposal of dead or diseased plants or animals.
6. List some antibiotics used in the treatment of animal diseases.
7. Discuss the possible merits and problems associated with the addition of antibiotics to feed given young animals such as chicks, turkeys poults, calves, etc.

LEARNING ACTIVITIES

- Examine microscopic slides of bacteria, fungi, protozoa and simple worms which cause diseases.
- Examine microscopic slides or preserved specimens of ticks, fleas and mosquitoes which act as intermediaries in the spread of certain diseases.
- Find out how local veterinary clinics, greenhouses etc. dispose of wastes and dead organisms.
- Ask a veterinarian, game warden, or agriculturist to speak on a subject related to this unit.
- Find out what is involved in the government inspection of meat, milk products, potatoes, nursery stock, etc.
- Find out what regulations govern the movement of plants and animals within the province, interprovincially and between Canada and other countries.
- Use antibiotic discs to show the effect of anitbiotics on a non-pathogenic bacterium such as *E. coli* or *B. subtilis*.

LEARNING OBJECTIVES

8. Discuss the problems met in treating soil to kill infective agents such as mematodes.

9. List some substances used to treat fungal and bacterial diseases in plants.

10. Explain why commercial green-houses are often fumigated between crops. List substances used for fumigation and the target organism for each.

11. List a number of ways of controlling the spread of animal diseases, listing one or more disease controlled by each method.

12. Give several examples of local, provincial and international quarentines of plants and/or animals.

13. Give ways that the individual farmer, logger or householder can prevent the spread of plant or animal diseases.

14. List a number of ways, (both commercially utilized and currently experimental) of controlling insects by biological means.

15. List the advantages and disadvantages of biological controls.

LEARNING ACTIVITIES

- Examine labels or packages of poultry etc. feeds to determine the kinds and amounts of antibiotics they contain. Find out the age animals these feeds are for.
- List the steps which would have to be taken if an epidemic broke out in cattle, sheep, chickens, or other domesticated animals.
- Report on what steps are taken to prevent the spread of a plant disease that appears in a single locality.
- Report on sanitation practiced on a dairy farm, feed lot, nursery or greenhouse.
- Debate the pros and cons of aerial spraying of forests, orchards or other crop lands.

Resources

Text

Heimler. *Focus on Life Science*: 252 ff.

Pamphlets (free)

Agriculture Canada.

Don't Bring It Back.
What You Should Know About Federal Meat and Poultry Inspection.

Environment Canada.

Biological Control of Insect Pests.
Forest Pests.

CHEMISTRY

ACIDS, BASES AND SALTS

Topics

Ionization Theory
Strengths of Electrolytes
Properties and Types of Acids and Bases
Nature and Naming of Salts
Neutralization Reactions and Chemical Indicators
Hydrolysis Reactions

Purpose

This chemistry unit deals with the theory of ionization and how it applies to the modern theory of acids and bases; the properties and strengths of acids, bases and salts; neutralization reactions, relationship between pH and hydronium/hydroxide ion concentrations and use of chemical indicators; and hydrolysis reactions.

Required Background

The equivalent of Grade 10 math; enough chemistry background to describe the general properties and classification of solutions, state and apply Le Chatelier's Principle; explain the effects of molecular polarity on the solubility of a solute in a solvent.

Key Ideas

- The properties of acids and bases are determined by their aqueous solutions of electrolytes.
- Acids always form hydronium ions in a water solution and bases contribute hydroxide ions.
- Salts are electrovalent compounds containing the positive ion of an aqueous base and the negative ion of a aqueous acid.

LEARNING OBJECTIVES

1. State the assumptions in the Arrhenius Theory of Ionization.
2. Describe and diagram the dissociation of an ionic compound in water.
3. Define and diagram the ionization of an acid in water.
4. Describe and diagram a hydronium ion.
5. Describe the terms "strong" and "weak" when referring to electrolytes.
6. Apply knowledge of the general properties of acids and bases and identify a sample liquid as an acid or base by appropriate laboratory tests.
7. Identify from its formula, an acid, base or type of salt.
8. Complete balance and identify various acid/base/salt reactions.
9. Recognize, write and balance neutralization reactions.

LEARNING ACTIVITIES

- Complete and label diagrams showing the dissociation of an ionic compound in water.
- Research Arrhenius theory of ionization and study diagrams or models depicting hydronium ions and the ionization of an acid in water.
- Conduct laboratory investigations to determine general properties of acid and base solutions.
- Prepare acid and base solutions in the laboratory.
- Classify some common household compounds as acids bases or salts based their formulas, components and knowledge of general properties of acids, bases and salts.
- Use chemical indicators to conduct the neutralization of an acid solution by a base solution.
- Do an acid base titration to determine the amount of alkali in soap.
- Devise an experiment to determine the molarity of a sodium hydroxide solution whose concentration is not known.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
10. Do simple calculations with neutralization equivalents.	- Write a research report on the action of buffers in the human body.
11. Define and describe the relationship between pH and hydronium/hydroxide ion concentration.	- Observe how salts can change hydronium or hydroxide ion counts in solution and determine approximate pH using indicators.
12. Name several acid-base indicators and give their colours in a specific pH range.	
13. Define and recognize hydrolysis reactions.	
14. Write and balance hydrolysis reactions.	
15. Predict whether hydrolysis will occur and describe the effect on the pH of the solution.	

Resources

Texts and Other Books

B.C. Ministry of Education. VAST 4 Chemistry: Unit 6, Topic B.

___________. Chemistry 12 Curriculum Guide (1978): Unit 3.

Kroschwitz, Jacqueline I., and Melvin Winokur. Chemistry: A First Course. New York: McGraw-Hill, 1980.

Ledbetter, Elaine, and Jay Young. Keys to Chemistry (metric ed.). Reading, Mass.: Addison-Wesley, 1977.

Metcalfe, H.C., and others. Modern Chemistry. New York: Holt, Rinehart and Winston, 1978.

Siebert, E.D. Foundations of Chemistry. New York: McGraw-Hill, 1982.

Whitman, R., and E. Zinck. Chemistry Today. Englewood Cliffs, N.J.: Prentice-Hall, 1982.

Films and Filmloops

Acid Base Indicators (PEMC #GS-612)
Conductivity of Solutions (HS Chem #6802 - Universal Education)
Use of a Burette.

BIOCHEMISTRY

Topics

What is Life?
Important Organic Compounds
Bioenergetics
Everyday Applications of Biochemistry

Purpose

In this general interest unit, learners will study some of the compounds that are essential components of most living things; the chemical systems that make up living systems and the methods living systems use to produce energy. Some medical and industrial applications of biochemistry will be examined.

Required Background

Intermediate unit on The Cell is strongly recommended.

Key Ideas

- The chemistry of living things is, in essence, the chemistry of organic compounds.
- The structure of the biological molecule is the key to its biological activity.

LEARNING OBJECTIVES

1. State the characteristics of living things.
2. Classify carbohydrates as mono-, di- or polysaccharides.
3. Discuss in simple terms the metabolism of carbohydrates in the body.
4. Give the general formula for fats and oils and state which fatty acids are essential to human diets.
5. Explain how a fat differs from an oil.
6. Write an equation for the saponification of a fat or an oil with caustic soda (NaOH).
7. Describe the structural feature that is common to all steroids.
8. List five foods that are major sources of protein and explain the meaning of di-, tri- and polypeptides.
9. State the significance of the primary structure of a protein.
10. Name the fundamental components of DNA and describe its structure.

LEARNING ACTIVITIES

- List a number of common objects as living or nonliving and determine the qualities or characteristics that divide living and nonliving.
- Study diagrams of various forms of carbohydrates and discuss how these are used by the body.
- Investigate the presence of reducing sugars in common foods by the use of Benedict's or Fehling's reagents.
- Study diagrams of fats and oils and explain the major difference between them.
- Test common foods for the presence of fats or oils.
- Research the claim that poly-unsaturated fats are preferred over saturated fats for human consumption.
- Investigate the properties of "soap" and the reasons it is biodegradable, and compare it to a "detergent".
- Prepare soap in the laboratory.
- Study charts or diagrams of the different protein types and explain the importance of their structure.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
11. Explain the concept of complementary bases and how this relates to DNA.	- Study models or diagrams of DNA and RNA discuss the relationship between complementary-base pairing and their structural differences.
12. List the structural differences between DNA and RNA.	
13. Discuss the role of enzymes in the body and the theory of how they function.	- Perform laboratory investigations to determine the properties of enzymes and their role in metabolism.
14. Define what is meant by "specificity" of an enzyme.	- Research or read about the "lock and key" theory of enzymatic action.
15. Explain the function of vitamins in the body and the results of vitamin deficiencies.	- Investigate the relationship between vitamins and enzymes and discuss the effects of vitamin deficiency on the body.
16. Explain the function of hormones in the body and explain how vitamins and hormones differ in origin.	- Research hormones and their influence on proper body functioning.
17. Describe, in general terms, the process of photosynthesis and the nature of the products formed.	- Investigate how plants are able to convert light energy into chemical energy and how this chemical energy is stored in chemical compounds.
18. Define and give examples of anaerobic and aerobic respiration.	- Investigate the release of energy by different organisms, e.g. bacteria, plants, animals.
19. Explain the relationship between photosynthesis and respiration.	- Research the biochemical compounds and reactions involved in control of bacterial infection with sulphur drugs; use of bacteria to clean oil spills, medical use of hormones, the chemical aspects of the dairy industry.
20. List examples of the use of biochemical molecules or processes in medicine or industry.	

Resources

Texts and Other Books

Curtis, Helena, and N. Sue Barnes. Invitation to Biology. New York: Worth, 1981.

Hein, Morris. Foundations of College Chemistry. Monterey, Calif.: Brooks-Cole, 1982.

Mader, Sylvia S. Inquiry Into Life. Dubuque, Iowa: Wm. C. Brown, 1982.

Ritchie, Donald, and Robert Carola. Biology. New York: Addison-Wesley, 1979.

Whitman, R., and E. Zinck. Chemistry Today. Englewood Cliffs, N.J.: Prentice-Hall, 1976.

Films

As listed under intermediate unit on The Cell.

NUCLEAR CHEMISTRY

Topics

Nuclear Structure and Reactions
Radioactive Decay
Uses of Nuclear Reactions and Radioactive Products

Purpose

Students will learn elementary nuclear structure, instability and interactions. Applications in medicine and energy generation will be studied.

Required Background

Intermediate units on Energy and Introductory Chemistry, or equivalent knowledge. Completion of the intermediate units on Electric Circuits and Waves would also be useful.

Key Ideas

- Isotopes are atoms which have the same atomic number but differ in mass.
- Radio-active substances give off alpha, beta and gamma radiation.
- Nuclear reactions, namely fission and fusion, are the source of nuclear energy.
- Nuclear reactions may produce usable forms of energy for applications such as medical therapy, or defence research.
- Any nuclear reaction must be accompanied by rigorous safeguards to prevent harmful radiation from entering the environment.

LEARNING OBJECTIVES

1. Define neutron, proton, isotope, alpha and beta particles and gamma radiation.
2. Determine the nuclear structure of an atom, given its atomic number and mass.
3. Compare the velocity and penetrating power of alpha, beta and gamma radiation.
4. Define natural radioactivity and name several naturally occurring radioactive elements. Locate these on the peiodic table.
5. Describe the process of radioactive decay in general terms, using Uranium 238 as an example.
6. Explain what is meant by a nuclear transformation, and how it differs from an ordinary chemical reaction.
7. Define and give examples of a synthetic element, and explain in general terms the process by which one is produced.
8. Define nuclear fission and give several examples of its natural occurrence. For each, state the fissionable element and the resulting products.
9. Explain the reactions involved in a nuclear reactor using U-235. Describe the purpose of a moderator in a reactor and name several moderators which can be used.

LEARNING ACTIVITIES

- Prepare flash cards with atomic number and mass on one side and numbers of neutrons and protons on the other, as an aid to memory.
- Report on the work of Marie and Pierre Curie, Becquerel or Rutherford.
- Read about and report on the Candu reactor.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
10. Describe a "breeder" reactor and explain how it differs from a reactor using a moderator. 11. Explain how the energy from nuclear fission is converted into electrical energy. 12. List advantages and disadvantages of using nuclear reactors to produce electrical energy. 13. Define thermonuclear reaction and explain how such a reaction differs from nuclear fission. 14. Describe several uses of radioactive isotopes in research. 15. List medical uses of radioactivity including x-rays, radiotherapy for cancer and use of radioactive substances in diagnosis. 16. Explain how naturally occurring isotopes can be used to determine the age of artifacts, and describe the limitations of such methods. 17. List sources of radiation which occur naturally in the environment. 18. List safeguards which must be observed in using radio isotopes. 19. Explain how a Geiger counter works.	- Organize a debate on nuclear power. - Report on the history of nuclear weapons, including developments such as the neutron bomb. - Report on radiography, research on photosynthesis, the "cobalt bomb" for cancer treatment, Carbon 14 dating and related archeological techniques. - Obtain a Geiger counter and use it in various locations.

Resources

Texts

Heath, Robert W., David Martindale and Robert R. MacNaughton. Fundamentals of Physics. Toronto: Heath Canada, 1981. Chapters 14, 15, 16.

Heimler and Price. Focus on Physical Science.

Metcalfe, H.C., and others. Modern Chemistry. New York: Holt, Rinehart and Winston, 1978.

Miller F., and others. Concepts in Physics. New York: Harcourt Brace Jovanovich, 1980. Chapter 25.

Read, A.J. Physics: A Descriptive Analysis. New York: Addison-Wesley, 1970. Chapter 14.

Instructor References

Rogers, E.M. Physics for the Inquiring Mind. Princeton, N.J.: Princeton University Press, 1960. Chapter 43.

Smith, Alpheus, and John N. Cooper. ELements of Physics. New York: McGraw-Hill, 1979.

Watt, George W. and others. Chemistry. New York: Norton, 1964. The chapter on Radioactivity and Atomic Energy, while not up-to-date, is very readable and not too technical for students who want to know more about nuclear chemistry, but are weak in physics.

Pamphlets (free)

Radiation is Part of Your Life
Candu 600
Heavy Water
Fundamentals of Nuclear Power
Safety of CANDU Nuclear Power Stations

The above and other related pamphlets and posters are available from: Atomic Energy of Canada Ltd.
Public Affairs Office
Sheridan park Research Community
Mississauga, Ontario L5K 1B2

Facts on Cancer Treatment (American Cancer Society) available from Canadian Cancer Society (B.C. & Yukon Div.) 955 West Broadway, Vancouver, B.C. V5Z 3X8.

OXIDATION AND REDUCTION

Topics

Reactions Involving Electron Transfer
Origin and Uses of the Activity Series
Application of Redox Reactions

Purpose

This unit focuses on the component parts of a redox reaction equation, the activity series, electrochemical cells and electrolytic cells, and the practical uses of redox reactions.

Required Background

Math 10 or its equivalent; knowledge of the four types of chemical reactions; ability to balance simple reactions by inspection.

Key Ideas

- Chemical reactions involve the rearrangement of electron structure.

- In a redox reaction, the processes of oxidation and reduction occur simultaneously.

- The degree of spontaneity among redox reactions determines the electrical energy produced or required by these reactions.

- Electron - transfer reactions occur in both living and non-living systems.

LEARNING OBJECTIVES

1. Define oxidation, reduction, oxidizing agent, reducing agent and give an example of each.
2. Use electronegativity data and/or an activity series, to predict the occurrence of an oxidation-reduction reaction and write a balanced equation.
3. Describe and diagram the components of an electrolytic and electrochemical cell.
4. Compare the oxidation and reduction reactions of the electrochemical and electrolytic cells.
5. Given an electrolytic cell used for electroplating, label the components and describe the process of electroplating.
6. Describe, with the aid of diagrams, the composition and operation of a lead-acid storage battery.
7. Draw a fully-labelled diagram of the voltaic cell, given two possible metal electrodes and a table of standard potentials.
8. Write half-reactions and calculate the potential difference across the cell.
9. Give an example of an electron transfer reaction found in a living system.

LEARNING ACTIVITIES

- Research material on electron-transfer reactions.
- Inspect a number of given chemical reactions and identify the half-reactions for oxidation and reduction, the reducing agents and oxidizing agents.
- Conduct laboratory investigations to demonstrate typical oxidation-reduction reactions, and the relative strengths of some oxidizing and reducing agents.
- Investigate electrochemistry by electroplating materials investigating cathodic protection of pipes and ships' hulls or by investigating the anodizing of aluminium.
- Determine the anode and cathode of a lead-acid storage battery when fully charged or discharged.
- Explain how the workings of a car battery are based on the principles of voltaic and electrolytic cells.
- Plan an experiment to design a voltaic cell with and without a salt bridge.
- Research the cytochrome systems present in photosynthesis and respiration and determine the role of redox reactions.

Resources

Texts and Other Books

See resources listed under advanced unit on Acids, Bases and Salts.

Periodical Articles

Doty, Gene. "A First Electrochemistry Laboratory." Science Teacher, 38 (February 1971): 49.

Hosler, C.F., and M.D. Jawson. "The Inhibition of Oxidative Processes by Tobacco Smoke." Science Teacher, 37 (December 1970): 55-57.

Films

	PEMC #
Bromine, Element from the Sea	GS-616
Electrochemical Cells	GS-710
Ionization Energy	GS-614
Oxidation-Reduction	GS-711

SOLUTIONS

Topics

General Properties of Solutions
Classification of Solutions
Nature of the Solution Process
Concentration of Solutions
Factors Affecting Solubility
Equilibrium in Solutions

Purpose

This unit is oriented especially to students considering a chemistry-related career such as in Health or Biological Sciences, or Oceanography. It is also suitable for general chemistry upgrading.

Required Background

Grade 10 Mathematics or equivalent. Sufficient background in chemistry to describe properties and changes in matter; explain changes in the states of matter; state factors influencing changes in matter; and explain the properties of the liquid state.

Key Ideas

- Solutions are homogeneous mixtures of two or more substances.

- Qualitative and quantitative factors affect the physical properties of solutions.

- The molecular nature of the solutes causes characterisitc changes in the freezing points and boiling points of solvents.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
1. Define solution, solute, and solvent.	- Research material on solutions.
2. Describe electrolytic and nonelectrolytic solutions.	- Classify common household solutions based on the knowledge of the possible combinations and how solutions are classified.
3. Identify and give examples of combinations of liquid, gas and solid which constitute a solution.	
4. Define miscible and immiscible.	- Apply knowledge of solutions to explain the following: stalagmites and stalactites in caverns, fossil records from the past, or natural pearls in oysters.
5. Define and explain with examples suspensions and colloidal suspensions.	
6. Describe and define solubility, unsaturated, saturated and supersaturated.	- Conduct laboratory investigations to determine: solubility curves, properties of solutions, molar volume of a gas or the Kinetic Molecular Theory.
7. Describe the effects of temperature and pressure on solubility.	- Explain and apply formuale to prepare solutions of known molarity prior to actual preparation of one or more stock solutions.
8. Explain the effects of molecular polarity on the solubility of a solute in a solvent.	- Given a number of practice work sheets, perform quantitative calculations involving solutions.
9. Define dilute and concentrated solutions.	
10. Explain changes of temperature during the dissolving process.	- Determine a number of situations outside the classroom in which the study of solutions would have practical applications.
11. Solve quantitative problems involving: - percentage by weight - percentage by volume - molality and molarity.	- Plan an experiment to determine the freezing point or boiling point of a water solution of either an ionic or molecular solute.
12. Compare the effects of ionic and molecular solutions on freezing and boiling points.	

Resources

Texts and Other Books

See resource list for advanced unit on Acids, Bases and Salts.

Films and Filmloops

Chemical Equilibrium: Le Chatelier's Principle. (High School Chemistry Super 8 series #6811. Universal Education and Visual Arts).

Conductivity of Solutions. (same series as above #6802).

Equilibrium. (PEMC #GS-610).

PHYSICS

ELECTROMAGNETISM

Topics

Permanent and Electric Magnets
Electric Motors and Meters
Transformers and Generators
T.V. Sets, Electron Microscopes and Particle Accelerators

Purpose

The magnetic force has many applications in modern technology. This unit deals with the principles that govern the operation of common electromagnetic devices.

Required Background

Completion of the intermediate units on Energy, Electric Circuits and Mechanics, or equivalent knowledge.

Key Ideas

- The two most common sources of magnetic fields are from a permanent magnet and from electric magnets.

- The force of a magnetic field on a current carrying conductor is used to operate electric motors and electric meters. A complementary effect is used to operate in generators and alternators - that of an electric current being produced by the motion of a conductor in a magnetic field.

- An electric current is also produced when a conductor is affected by a varying magnetic field.

- Electric currents not confined to conductors but free to move through space can be directed by electro-magnetic fields.

LEARNING OBJECTIVES

1. Describe the properties of permanent magnets.
2. Describe the magnetic field of a current carrying conductor.
3. Compute the magnetic field strength associated with an electric coil.
4. Compute the force on a conductor when the conductor moves in a magnetic field.
5. Describe the operation and label the principal parts of a moving coil meter.
6. Convert a meter movement to a volt meter or ammeter by inserting the appropriate series or shunt resistor.
7. Describe the operation and label the parts of simple AC and DC motors.
8. Claculate the current induced by the motion of a conductor in a magnetic field.
9. Describe the operation and label the parts of a DC generator and an alternator.

LEARNING ACITIVITIES

- Investigate the properties of permanent magnets.
- If large industrial currents are available, study their magnetic fields.
- Build electric coils and determine the shape and extent of the magnetic field.
- Investigate the effect of inserting various materials into electric coils.
- Use or make of current balance.
- Disassemble an electric meter.
- Research different types of meter movements.
- Investigate the production of an electric current using a coil, a magnet and a meter.
- Dissect an electric motor, generator or alternator.
- Construct a rectifier circuit.
- Build a transformer.
- Research an electrostatic precipitator or a photocopy machine.

LEARNING OBJECTIVES	LEARNING ACITIVITIES
10. Describe the rectification of AC to DC using diodes.	- Investigate the production of Northern Lights and the earth's magnetosphere.
11. Describe the principles of operation of a transformer.	
12. Calculate the secondary voltage and current of a transformer given the primary voltage and current and the turns ratio.	
13. Locate the transformers in an electric power distribution network and state the reasons for their presence.	
14. Describe the operating principles of a tape recorder.	
15. Determine the direction and magnitude of a moving free charge in an electric field and in magnetic field.	
16. Describe the production of light in a CRT screen.	
17. Describe the operation of devices such as TV sets, particle accelerations, electron microscopes and fusion reactors.	

Resources

Texts

Miller, F., and others. Concepts in Physics. New York: Harcourt Brace Jovanich, 1980. Chapter 18.

Read, A.J. Physics: A Descriptive Analysis. New York: Addison-Wesley, 1970. Chapters 10, 11.

Rogers, E.M. Physics for the Inquiring Mind. Princeton, N.J.: Princeton University Press, 1960. Chapters 34, 37, 38.

Instructor References

Harris, Norman C., and Edwin M. Hemmerling. Introductory Applied Physics. New York: McGraw-Hill, 1980.

Smith, Alpheus and John N. Cooper. Elements of Physics. New York: McGraw-Hill, 1979.

MECHANICS AND MOTION

Topics

Motion and Newton's Laws
Work, Energy and Momentum
Electrostatic Force and Universal Gravitation

Purpose

Students will learn how to describe the motion of objects and to predict what happens when forces act on objects. Study of the Coulomb electric force and universal gravitation will lead to an understanding of the way forces originate.

Required Background

The intermediate units on Electric Circuits, Energy, Machines and Waves, or equivalent knowledge. The ability to manipulate formulas.

Key Ideas

- The mathematics of signed numbers and vectors are used in mechanics.
- Once a coordinate system is established, displacement, velocity and acceleration are used to describe an object's motion.
- Newton's Second Law summarizes the relationship between for force applied to a mass and the subsequent motion of the mass.

- The laws of conservation of energy and momentum are used to determine an object's final motion when some initial conditions are specified.

- The law of universal gravitation provides an explanation of the gravity force.

- Coulomb's law provides an explanation of the electric force.

- When objects are moving at high speeds or when the objects are very small, Newtonian mechanics is replaced by, respectively, the theory of special relativity and the quantum theory.

LEARNING OBJECTIVES

1. Manipulate signed numbers.
2. Define a one-dimensional coordinate system to describe the motion of an object.
3. Define and determine the displacement, velocity and acceleration of an object in one dimensional motion.
4. Compute the velocity and displacement of an object when the acceleration is constant by using the one dimensional kinematic equations.
5. Define mass and force.
6. State the postulates of special relativity and calculate relativistic lengths, times and masses.
7. State Newton's laws of motion and, in the case of a constant force, determine the displacement, velocity and acceleration of a given mass.
8. Distinguish between mass and weight.

LEARNING ACTIVITIES

- Measure the displacement, velocity and acceleration for moving objects such as a bicycle, a bus, a runner, a car and a merry-go-round or ferris wheel.
- Perform experiments under constant acceleration to demonstrate the kinematic laws. These can be done on an air track of with pulley systems.
- Measure the forces on an object in equilibrium to demonstrate Newton's first law.
- Research the background of the development of special relativity.
- Write a biography of Newton, Einstein, Coulomb, Kepler or Bahr.
- Determine how seat belts prevent injury.
- Study the development of Kepler's laws.

LEARNING OBJECTIVES	LEARNING ACTIVITIES
9. Manipulate 2 dimensional vectors and vector equations.	- Compare the electric force and the gravitational force.
10. Define and determine the displacement, velocity and acceleration of an object moving in two dimensions.	- Research the background to the development of the quantum theory.
11. Determine the displacement and velocity of an object moving in two dimensions when the acceleration is constant.	
12. Describe the motion of an object moving under the effect of a central force.	
13. State the laws of conservation of mechanical energy and momentum and the conditions for their application.	
14. Use the laws of energy conservation and momentum in appropriate situations.	
15. State the law of universal gravitation and calculate the force between two masses.	
16. State Coulomb's law and use it to calculate the force between two charges.	
17. State the assumptions in the Bohr model of hydrogen and the successes of this model.	

Resources

Texts

Heath, Robert W., David Martindale and Robert R. Macnaughton. Fundamentals of Physics. Toronto: Heath Canada, 1981. Unit 1.

Miller, F., and others. Concepts in Physics. New York: Harcourt Brace Jovanovich, 1980. Unit 2 and Chapter 14.

Read, A.J. Physics: A Descriptive Analysis. New York: Addison Wesley, 1970. Chapters 2, 3, 4.

Instructor References

Bolton, W. Patterns in Physics. New York: McGraw-Hill, 1974.

Rogers, E.M. Physics for the Inquiring Mind. Princeton, N.J.: Princeton University Press, 1960. Part One.

Smith, Alpheus, and John N. Cooper. Elements of Physics. Part 1 and Chapter 45.

EARTH SCIENCES

EARTH RESOURCES

Topics

Renewable Resources
Nonrenewable Resources
Resource Problems

Purpose

The purpose of this unit is to develop awareness of the many social, political and economic implications which result from dependence on minerals and resources which are exhaustible or irreplaceable.

Required Background

None, although the intermediate unit Earth Science would provide useful background.

Key Ideas

- Mineral resources such as fossil fuels, metals, soil and water have become essential ingredients for modern life.
- Nonrenewable resources include those minerals of the earth requiring millions of years to form, or those formed by geological processes that may not be repeated.
- In the efficient development of renewable resources, environmental protection and conservation factors must be addressed.

Learning Objectives and Activities

Appropriate learning objectives and activities for this unit may be selected from the Earth Science 11 and Geology 12 Schools Curriculum Guides.

Resources

As listed in:

Earth Science 11 - Curriculum Guide. Victoria, B.C.:
Ministry of Education 1977: 58-68.

Geology 12 - Curriculum Guide. Victoria, B.C.:
Ministry of Education 1977: 77-89.

HISTORICAL GEOLOGY

Topics

Time and Measurement of Time
Fossil Record
Interpreting the Geological Record

Purpose

The purpose of this unit is to develop awareness of the methods of measuring time and of the scale of time necessary for the earth's history to unfold. In addition, this unit provides an opportunity to investigate the relationships and time scales suggested by the fossil record.

Required Background

None.

Key Ideas

- The establishment of a geological time scale has had a critical impact on the development of scientific knowledge, as well as on human philosophy.

- The fossil record provides an understanding of the process by which living organisms have changed or evolved.

Learning Objectives and Activities

Appropriate learning objectives and activities for this unit may be selected from the Earth Science 11 or Geology 12 Curriculum Guides.

Resources

As listed in:

Earth Science 11 Curriculum Guide. Victoria, B.C.: Ministry of Education 1977: 34-40.

Geology 12 Curriculum Guide. Victoria, B.C.: Ministry of Education 1977: 51-69.

See also resources listed for intermediate geology units.

PHYSICAL GEOLOGY

Topics

Earth Materials
Earth Processes
Structural Geology

Purpose

This is an introductory unit on rocks and minerals in the context of the nature and organization of matter. The study is basic to an understanding of many geological processes. These geological processes can occur both at a surface level and at a subsurface level and are responsible for shaping the earth. Students will relate the major geological processes to the evolution of the layers of the earth and the development of the broad patterns of the earth's crust.

Required Background

The intermediate unit Earth Science, or equivalent knowledge of the properties of rocks and minerals and the changes that occur in the earth's surface.

Key Ideas

o All rocks are composed of minerals which can be easily identified by their physical and chemical properties.

- Rocks can be classified into three major categories according to their formation.

- Surface earth processes, such as past ice ages, glaciers, physical erosion, ground water, running water and weathering, breakdown and redistribute earth materials. The products of such surface earth processes provide the materials for sedimentary rock formations.

- Subsurface earth processes are responsible for the many deformation features evident throughout the earth's crust. The nature of the deformation is dependent on factors such as pressure, temperature, time and composition of the rock.

- Continental drift, plate tectonics, sea floor spreading and mountain building are some of the major geological processes responsible for the evolution of the earth.

Learning Objectives and Activities

Appropriate learning objectives and activities for this unit may be selected from the Earth Science 11 or Geology 12 Schools Curriculum Guides.

Resources

Earth Science 11 Curriculum Guide. Victoria, B.C.: Ministry of Education 1977: 20-28.

Geology 12 Curriculum Guide. Victoria, B.C.: Ministry of Education 1977: 13-47.

See also resources listed for intermediate geology units.

PRINCIPLES OF ADULT LEARNING

Adult education instructors tend to agree on a number of generalized observations about how and why adults learn. It may be reassuring to discover that these observations are well supported by a steady stream of research studies and syntheses of knowledge about adult learning. The following list is extracted from Knox (1978); similar principles are listed by Kidd (1973), Dickinson (1973), and Brundage and MacKeracher (1980).

1. **Performance**: Adult learning usually entails change and integration of knowledge, skills, and attitudes to produce improved performance. Adults typically engage in a continuing education activity because they want to use what they learn soon after they learn it.

2. **Motivation**: The educational goals, sources of encouragement, and barriers that characterize an adult's life situation shape the reasons for participation. Motives are multiple and varied in their specificity and in the extent to which the learner is aware of them. Overly intense motivation becomes anxiety, which interferes with learning.

3. **Meaning**: Adult learning is more effective when it entails an active search for meaning and discovery of relationships between current competence and new learnings.

4. **Experience**: An adult's prior experience influences the approach to a learning episode and its effectiveness. Prior learning may either facilitate, interfere with, or be unrelated to new learnings.

5. **Learning Ability**: Learning ability is relatively stable between 20 and 50 years of age, with gradual decline thereafter; abilities that are associated with adult experience, such as vocabulary, are best maintained and enhanced; and adults who were initially the most able of their age group tend to increase their ability so that the range in abilities increases with age. Adults with the greatest learning ability tend to learn more rapidly and to learn complex tasks more readily.

6. **Memory**: An adult's ability to remember information depends on the strength of the registration and on the factors operating to erase the registration. The strength of registration depends on intensity, frequency, and importance to the learner. The factors that erase the registration include the passage of time and the activity that follows the exposure. Recall is best under conditions that are similar to the original registration.

7. **Condition**: An adult's ability to learn can be substantially reduced by poor physical and mental health. Condition and health include both gradual decline into old age and temporary problems. The decline for older adults in their vision and hearing can affect learning. Much can be corrected by glasses, better illumination, hearing aids, and sound amplification.

8. **Pacing**: Adults typically learn most effectively when they set their own pace. Adults vary greatly in the speed at which they learn best. Older learners tend to reduce the speed of learning and to give greater attention to accuracy.

9. **Complexity**: An adult typically learns best when the learning task is complex enough not to be boring, but not so complex that it is overwhelming.

10. **Content**: The process of effective learning by adults varies with the content or nature of the learning task.

11. **Feedback**: Adults learn more effectively when they receive feedback regarding how well they are progressing. This applies to learners of any age. Immediate feedback, recognition, and reward help to shape and reinforce new learning.

12. **Adjustment**: Adults typically learn less well when they experience substantial social or personal maladjustment. When adults believe they can deal with a situation, it may represent a challenge; when they do not, it may be perceived as a threat.

Professional References

Brundage, Donald H., and Dorothy MacKeracher. Adult Learning Principles and Their Application to Program Planning. Toronto: Ontario Institute for Studies in Education, 1980.

Dickinson, Gary. Teaching Adults: A Handbook for Instructors. Toronto: New Press, 1973.

Kidd, J. Roby. How Adults Learn. New York: Association Press, 1973.

Knox, Alan B. "Helping Adults to Learn". In Yearbook of Adult and Continuing Education (1978-79). Chicago: Marquis Academic Media, 1978.

ADVISING AND PLACING STUDENTS

It is assumed that the reading ability of students enrolled in ABE Science courses will be such that they can learn without difficulty from text materials at about the level of those recommended. For most units, a basic knowledge of arithmetic and the (SI) metric system is required. Advanced units in Physics and Chemistry require basic algebra.

Specific unit selections will normally be determined by instructor-student conference. Whenever possible, a student should be given some choice within the limits of program offerings and further educational requirements.

The following are hypothetical examples of individual student course selections:

- Mary G: Late teens, recent drop-out, needs Grade 10 for hairdressing training, says she "hates science - its boring"; local requirement for Grade 10 equivalency certificate is 8 units.

Recommended Course: Level 3 with General Science Emphasis

3 Fundamental units plus 5 Intermediate units chosen from:

Consumer Chemistry
Disease
Drugs and their Use
Fitness and Health
Food
Human Biology
Human Growth and Development
Nutrition
Work, Home and Recreation Safety

- Alan J: Recent drop-out, about 18 years old, thinking of auto mechanics, unsure reader, Math slow but improving; local requirement for pre-vocational Science is 3 fundamental units plus 5 others.

Recommended Course:
Level 3 with Physical Science Emphasis

Fundamental:
Skills and Processes of Science
Properties of Materials and Atomic Structure
Science and Technology

Intermediate:
Energy
Simple Machines
Electric Circuits
plus 2 options

- Joan W: Has been away from school over 10 years, reads well, Math weak, wants GED; no minimum local requirements.

Recommended Course:
Level 3 with General Science Emphasis

Fundamental:
Skills and Processes of Science
Properties of Materials and Atomic Structure

Intermediate: 4-6 units, from:

The Cell: Basic Unit of Life
Chemistry: Introduction
Earth Science
Energy
Nutrition
Simple Machines
Weather

- Don J: Has completed Grade 10 plus some Grade 11, needs Grade 12 equivalency to enter health science program (medical technology).

Recommended Course

Level 4 with Life Science Emphasis

Fundamental:	Computer Literacy
Intermediate:	The Cell: Basic Unit of Life
Advanced:	Acids, Bases & Salts
	Biochemistry
	Body Systems 1
	Body Systems 2
	Disease and Treatment in Humans
	Diseases of Plants and Animals or Human Inheritance
	Nuclear Chemistry
	Oxidation - Reduction
	Solutions

In cases like this, it is important to check with a counsellor or with the transfer institution on exact entry requirements and acceptability of proposed ABE course or program.

If the institution offering the technical training requires Biology 12 and Chemistry 11, refer to the section on course comparisons in Part 1 of this Guide.

EVALUATION OF STUDENT PROGRESS

In ABE Science courses, several key decisions must be made concerning the method and procedures of evaluating student progress.

Many instructors prefer (and some institutions require) formal evaluation by tests. However it is possible to evaluate student progress on the basis of day-to-day class work, written assignments, participation in discussion, etc. These are more natural methods than formal testing and may be less stressful for students. On the other hand, the instructor's marking load is likely to be greater.

Some ABE programs use formal tests at the end of each unit, and also require a final examination at the end of the course. If a broad choice of possible units is available, then preparation of a final examination will require careful advance planning.

An important aim of the Science curriculum is to equip students with the knowledge needed to use or understand science in daily life as well as in training for careers. Any testing should therefore emphasize the understanding of basic scientific principles rather than the recall or recognition of isolated facts.

Guidelines for Test Construction

A student is asked to write a test or do a lab exercise. The instructor does not want an evaluation to take too much time to prepare, or too much time to mark. The following guidelines are suggested to facilitate the task for both student and instructor.

First, the purpose of evaluation should be clear, so that tests can be constructed to suit that purpose. Typically, three types of tests are commonly used, each with a distinct purpose.

- *Placement tests* find out if a course is appropriate for a student. Do students know the course content and laboratory skills already? If not, do they know enough to begin?

- *Formative tests* measure how well students are achieving learning objectives, for the purpose of improving instruction. When objectives are not met, the material may need to be retaught or additional lab work assigned. These tests are *not* used in the determination of letter grades for students.

- *Summative tests* determine if learning objectives have been attained to such an extent that a student has 'completed' a unit or course of instruction. These tests may be used to determine letter grades, and/or competence to proceed to a new learning objective.

Other uses of tests may include providing motivation, increasing retention and transfer of ideas, or increasing understanding. In these senses, they are more akin to instructional techniques than assessment devices.

General Principles of Test Construction (Gronlund, 1977)

1. Tests should measure clearly defined learning outcomes that are in harmony with the instructional objecives.

2. Tests should measure a representative sample of the learning outcomes and subject matter included in the instruction.

3. Tests should include the type of test items that are most appropriate for measuring the desired learning outcomes.

4. Tests should be designed to fit the particular uses to be made of the results.

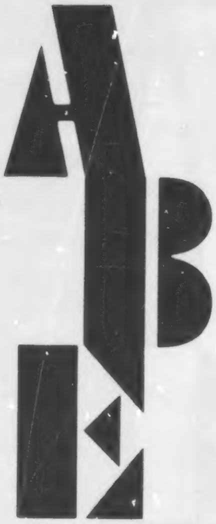
5. Tests should be as reliable as possible and should then be interpreted with caution.

6. Tests should be used to improve student learning.

Critical tasks in test construction include the selection of test items, ensuring correct interpretation of the question, and the assignment of marks.

Test scores may be norm-referenced - i.e. may indicate how an individual's performance compares to that of others - or may be criterion-referenced - i.e. indicating how performance compares to a pre-set standard. Criterion-referenced testing may also be called mastery testing. Letter grade systems may be developed for either approach. Whichever is used, a score interpretation guide should be prepared for students and other instructors.

It should be noted, however, that evaluation is not the same as grading. Evaluation is, at best, a continuous process which enables both learner and instructor to control learning, somewhat along the lines of a system's thermostat. Evaluation is thus most effective if it directs corrective action before learning difficulties get out of control.



SCIENCE LABORATORY RESOURCES

Common Lab Equipment

Beakers - 100 ml
  250 ml
  400 ml
  600 ml
Beam balance
Boiling chips
Bunsen burners
Burette clamp
Chromatography paper
Coverslips
Dissecting pan
Dissecting needles
Evaporating dish
Filter paper
Flasks - 250 ml
Forceps
Funnels
Glass slides
Glass solution bottles
Glass tubing
Glass U-tube
Graduated cylinders 10 ml
  25 ml
  50 ml
  100 ml
Hand lens (3x, 6x)
Iron filings
Lever apparatus
Litmus paper
Wire gauge

Magnet bar
Masses 5g/10g/20g/50g/100g/250g/500g
Meter stick
Microscope
Medicine droppers
Mortar & pestle
Plastic bottles
Prism
PTC Taste paper
Pulleys (single, double)
Rods-rubber, glass
Ring stand and ring
Rubber tubing
Safety goggles & aprons
Spark lighters
Spring scales
Stirring rods
Stoppers - test tube size
  - one hole, two hole
Test tubes - various sizes heat resistant
Test tube clamps
Test tube holders
Test tube rack or stand
Thermometer (Celsius)
Tongs, flask
Tripod stand
Watch glass
Wooden Splints

Chemical Supplies

Home, School or Local Store

Alcohol, rubbing
Antacid tablets
Baking soda
Bleach, liquid
Distilled water
Effervescent tablet
Food coloring (red, green, blue and yellow)

Kerosene 0.5 litre
Mineral oil
Salt
Soda water
Sugar cubes
Sugar, granulated
Vinegar

From Chemical Suppliers

Ammonium hydroxide
Ammonium nitrate
Bromothymol blue
Copper II sulfate
Glucose
Glucose testing tablets
 (Clinitest)
Glycerine
Hydrochloric acid 6M/1M
Hydrogen peroxide
Lead acetate
Lead nitrate
Nitric acid
Methanol
Ethanol
Methyleme blue
Mossy zinc
Phenolphthalein solution
Potassium chlorate
Potassium dichromate
Potassium iodide
Silver nitrate
Sodium hydroxide pellets
Sodium nitrate
Sulphur, powdered
Slphuric acid
Tincture of iodine
Acetone
Carbon tetrachloride
Potassium hydroxide

Biology Supplies

From Home, School, or Local Store

Cotton batting
Dairy products
Elodea
Fresh produce
Grass, compost or hay
 (for infusions)
Pond water
Seeds - bean, corn, radish
Thread - cotton, nylon and
 wool
Yeast
Molasses
Dice
Single-edged razors

From Biological Suppliers

Benedict's solution
Blood typing solutions
 (anti A, anti B, anti Rh)
Capillary tubes
Cell models (plant, animal)
Corn cobs (for genetics)
Dialysis tubing
Ethanol, or alcohol swabs
Lances-sterile (for blood samples)
Mitosis-meiosis kits or models (Carolina Biological Supply)
Prepared slides - cheek epithelial
 - onion root tip (mitosis)
 - assorted protists and protozoans
 - drosophilia DNA
 - frog ovary & testis
 - human biology - blood, muscles, bone, liver, spinal cord, kidney, endocrine glands
 - plant anatomy - monocot, dicot root, stem, leaves, pollen, etc.
 - zoology, earthworm, crayfish, grasshopper.

Preserved specimens (a few representative specimens of each major kingdom or phylum).

Pancreatin
Pepsin
Talquist scale
Wright's stain
Lugnol's solution (IKI)
Test papers (urinalysis)
Scalpels
Limewater (Ca(OH))

SCIENCE LABS: Making Do With a Minimum

While it is clearly desirable to conduct science instruction in a laboratory setting of some type, many ABE science instructors find themselves without conventional lab facilities. Science classes may be scheduled in a multi-purpose room, a church basement, auditorium or even in a renovated farmhouse.

Nevertheless, with a little ingenuity and cooperation, a number of ways may be discovered to adapt existing space and resources to provide a practical area for group instruction or individual study. The following suggestions have been gleaned from several resource books.

Work Space For Demonstrations and Activities

Sufficient work space is essential in operating a lab-oriented science program. Both a laboratory demonstration table and space for students to work in small groups are required. A transportable demonstration table of the type illustrated, for instance, may be ordered through a scientific supplier or may be built locally.

An advantage of the portable laboratory cart is that it can easily be transported from one area to anotner. It should contain work space, sink and storage cupboards.

Work Space For Small Group Work

Where student work is designed to be done in small groups, moveable tables are most convenient. A number of arrangements are suitable for small group work, and access by the instructor.

Bench space alongside windows or walls may be used for plants, aquaria or experiments left overnight. Shelves can also be readily constructed from old doors or plywood and attached to the wall or window sill.

Equipment and Materials

Existing equipment and materials may be supplemented by articles collected from local sources by instructors or students. For instance, jars of assorted sizes, egg cartons, plastic boxes, tin cans, plastic bottles, aluminum wire, metal screens etc. may be gathered and used 'as is' or reconstructed as substitutes for more expensive laboratory equipment.

Some examples of ways to adapt common articles for the science lab include:

- Test tube holder: Turn an egg carton upside down and cut holes in each egg compartment.

- Beakers: Use tin cans with the top completely removed, to heat water or other liquids.

- Graduated cylinders: Use measuring cups, glass baby bottles, olive jars or peanut butter jars (which are calibrated in metric units).

- Burner stands; These may be made from large juice tins which have been cut with tin snips into the form of tripods. Another stand may be made from a metal screen which has been folded over some heavy gauge aluminum wire.

- Clamps and holders: Wooden spring-type clothespins, small C-clamps or spring-back steel clamps designed for holding paper together can be used to heat and hold narrow test tubes while heating or to attach apparatus to a stand.

- Storage containers: For liquids, use plastic quart (litre) or gallon (4 litre) jugs which have been washed and clearly relabelled to show common name, chemical name and formula of liquid contents. For equipment, use cardboard shoe boxes or plastic containers which stack easily.

- Heat sources: Adapt an alcohol burner, an electric hot plate or a liquid petroleum burner when a concentrated source of heat is required.

- Water sources: Large receptacles may be constructed from polyethylene carboys with attached spigots or a rubber extension hose and clamp, plastic bottles, or from two trash cans - one of which has had a faucet attached. It is best to use a plastic trash can for collection so as to avoid any reactions with corrosive materials.

Making Simple Laboratory Equipment

Although certain equipment may have to be purchased from a scientific supplier, many items of common basic laboratory equipment may be made locally. This may even prove to be a valuable experience for students, as they practice basic skills and techniques, and see the results of their endeavours in the equipment they will use in the lab.

- Balance and weights: A fairly accurate all-purpose balance and a microbalance can be made from common inexpensive materials.

All purpose balance

- razor (double edged)
- wood for base
- wood for beam
- post
- string
- plastic circles for pans

For detailed instructions consult Teaching High School Science Sourcebook for the Physical Sciences (1961).

Microbalance

- block of wood
- two halves of a microscope slide
- two very fine sewing needles
- drinking straw
- 2.5 cm wood screw
- styrofoam

For detailed instructions and other forms of simple microbalance, see Joseph (1961, pp. 27-28.)

o Glassware - Florence flasks, funnels, battery jars, beakers and other items may be cut from strong glass bottles or made from used 100 watt or 500 watt light bulbs. Detailed instructions are provided in p. 604 of the Sourcebook referenced above.

Microscopes - Often, there are not enough microscopes to go around. In these circumstances instructors might consider using a microprojector, or even a library microfiche. An advantage of the microprojector is that it allows a group of students to view a fairly large image simultaneously. Microprojectors may be obtained from a scientific supplier or improvised locally from a microscope and a lantern project or Refer to Brandwein, A Sourcebook for the Biological Sciences (1966, p. 94).

Ways to Extend the Classroom

Locations outside may provide students with an alternate environment in which to study science. For example:

Greenhouse: may be associated with student projects (e.g. soil testing techniques, plant physiology) or serve as a means of supplying fresh living materail for study.

Schoolgrounds, Park or Forest: may provide a natural setting for students to study the principles of ecology. Outdoor experiences may stimulate deeper appreciation of the biological world, especially the interacting factors in the conservation of living things.

Darkroom: may be a spare closet that can be completely darkened or a portable darkroom built from a carton or wooden box and filled with a light tight cover. Students could develop their own photographs, improvise with photographic devices and study the effects of light and colour. Refer to A Sourcebook for the Physical Sciences, pp. 487-492.

REFERENCES

Joseph, Brandwein et al. A Sourcebook for the Physical Sciences, New York: Harcourt Brace and World, 1961.

Morholt, Brandwein, and Joseph. A Sourcebook for the Biological Sciences. New York: Harcourt Brace and World 1966.

Kaskel, Dalton, and Baruch. Principles of Science - Activity Centered Program Teachers Guide. Merrill, 1979: iv-xi.

Huggins, Marilyn. "Science on a Shoestring", Unpublished resource book. Trail, B.C.: Selkirk College.

RESOURCES UNDER REVISION
ILLUSTRATIONS TO BE ADDED

INSTRUCTIONAL RESOURCES: PRINT MEDIA

This section contains brief annotations of keyed texts and other books frequently listed as resources in the foregoing units, as well as some other books found useful in the field. It is not intended to be a comprehensive listing of all resources available. Instructors knowing of other consistently useful resources are requested to forward titles (with author, publisher and brief annotations) to the Coordinator of Adult Basic Education, Ministry of Education, Victoria, for possible inclusion in future editions of this curriculum guide.

Keyed Texts

Bishop, Margaret S., Berry Sutherland and Phyllis G. Lewis. Focus on Earth Science. Columbus, Ohio: Merrill, 1932.

A good instructional text for intermediate earth science. Attractive layout, with good coverage of the universe, solar system, earth-moon system, earth history, physical geology, atmosphere, hydrosphere and the environment.

Heimler, Charles. Focus on Life Science. Columbus, Ohio: Merrill, 1982.

Useful learning materials for intermediate biology units. Emphasizes practical study of the features and functions of living things. Attractive layout with a variety of activities problems and study questions. Good coverage of Ecology, Human Biology, Reproduction and Heredity, Plants and Animals, Microbes and Disease. Latest edition may need adaptation for adult students.

Heimler, Charles, and Jack Price. Focus on Physical Science. Columbus, Ohio: Merrill, 1982.

Easy-to-read, comprehensive text. Many excellent lab ideas, activities and study questions. Good coverage of force and work, machines, matter, atomic and molecular theory, basic chemistry, light and sound, heat, electricity, magnetism and nuclear energy.

Heimler, Charles, and Charles D. Neal. Principles of Science: Books 1 and 2. Columbus, Ohio: Merrill, 1982.

Very useful instructional resources covering most intermediate science topics. Easily read with excellent layouts and a wide variety of activities, problems and study questions. Good coverage of topics including Matter and Energy, Mechanics, The Earth, Living Things, Human Biology, Astronomy, Chemistry, Energy and Ecology.

Other Resources

General Science

Individualized Science Instructional System (ISIS). Lexington, Mass.: Ginn, 1976-1981.

A set of 25-30 minicourses which may be mixed and matched for use in intermediate units. Each module contains easy-to-read student workbooks, annotated teacher edition and tests along with kits of practical, everyday materials. Originally designed as high interest, easy readability school program, has been tried out with some success in adult courses. Was co-sponsored by U.S. National Science Foundation. Content emphasizes real-life themes and ideas, with topics such as Heart Attack, Stormy Weather, Household Energy, Birth and Growth, Food and Microorganisms, Sounds of Music, Kitchen Chemistry, Actions and Reactions.

Science Reader. New York: Readers Digest Educational Division, 1974.

A very useful series of short booklets covering a wide variety of topics, at an easy reading level. Written for adults.

Biology

Berry, Gordon S., and Harold P. Gopaul. Biology of Ourselves: A Study of Human Biology. Rexdale, Ont.: Wiley Canada, 1982.

Good instructional text which relates biology to the study of the Human Body. At the end of each chapter are questions for review and a variety of activities including labs. Good readability. Could supplement to intermediate biology units or be used in conjunction with another text for Biology 11-12.

Biological Science Curriculum Study (BSCS). Biological Science: An Ecological Approach (Green Version). Chicago: Rand MnCally, 1973.

Good supplementary text for intermediate or advanced units. An ecological approach to all topics. Good coverage of ecology, diversity of life, plant and animal physiology, cellular biology, heredity and evolution.

Curtis, Helene, and N. Sue Barnes. Invitation to Biology. New York: Worth, 1981.

Useful resource for instructors or students doing advanced units. Could be used in conjunction with Biology 11/12 curriculum guide. Excellent organization, chapter summaries, study questions and current information. Well written explanations, and clear diagrams.

Mader, Sylvia S. Inquiry Into Life. Dubuque, Iowa: Wm. C. Brown, 1982.

Suitable learning resource for more advanced topics in biology especially human biology. Good coverage of the cell, plant biology, reproduction, heredity, evolution and ecology.

Rahn, Joan E. Biology: The Science of Life. New York: Macmillan, 1980.

Good learning resource for advanced units. Clear explanations and diagrams. Up-to-date information and good coverage on cell biology, flowering plants, the human body, heredity, evolution, ecology and the environment. Could be used with Biology 11/12 curriculum guide.

Scarrow, Hart R. Bodyworks: Your Human Biology. Markham, Ont.: Globe/Modern Curriculum, 1979.

A collection of interesting laboratory exercises to supplement Human Biology units. Each chapter begins with an introduction which describes a particular body system, followed by one or more laboratory exercises. Easily adaptable to a variety of teaching situations.

Volpe, E. Peter. Biology and Human Concerns.

Good resource for instructors or students in advanced units. Up-to-date information on many topics of adult concern, with good coverage of life processes, human physiology, heredity, evolution, ecology and behaviour. Could be used with Biology 11/12 curriculum guide.

Chemistry

Kroschwitz, Jacqueline, and Melvin Winokur. Chemistry: A First Course. New York: McGraw-Hill, 1980.

Good learning resource for advanced units, including chapter summaries and other study aids. Includes many solved problems, clear explanations and comprehensive coverage of topics. Suitable for use with Chemistry 11/12 curriculum guidde.

Metcalfe, H.C., and others. Modern Chemistry. New York: Holt, Rinehart and Winston, 1974.

Reference text for advanced units. Reading level on the high side. Up-to-date information, good diagrams, tables and glossary.

Hein, Morris. Foundations of College Chemistry. Monterey, Calif.: Brooks-Cole, 1982.

Useful student resource, incorporating chapter objectives and summaries. Up-to-date coverage of topics, comprehensive glossary and appendix of problem solutions. Suitable for use in advanced units or with Chemistry 11/12 curriculum guides.

Toone, Ernest R., and George L. Ellis. Foundations of Chemistry (SI Metric edition). Toronto: Holt, Rinehart and Winston of Canada, 1978.

Good resource for instructors or students. Should be supplemented with companion lab manual. Clear explanations and solved problems. Recommended for advanced units and Chemistry 12.

Turner, A.M., and C.T. Sears. Inquiries in Chemistry. Rockleigh, N.J.: Allyn and Bacon, 1974.

Emphasizes learning of the scientific method. Lab activities require students to apply the processes of observing, hypothesizing, predicting and testing. Good coverage of most topics.

Whitman, R., and E. Zinck. Chemistry Today. 2nd edition. Scarborough, Ontario: Prentice-Hall, 1982.

Excellent instructional resource for advanced units. Latest edition has improved format, including key learning objectives and many solved problems. Relates theory to real-world examples. Numerous questions, problems and chapter overviews. Up-to-date, with clear explanations. Suitable for use in Chemistry 11/12.

Physics

Giancoli, Douglas C. The Ideas of Physics. New York: Harcourt Brace Jovanovich, 1978.

Excellent introductory textbook. Presents the basic ideas of physics with a minimal use of mathematics. Up-to-date inforamtion and good coverage of topics such as fluids, heat transfer, energy sources motion, light and colour. Good layout with numerous questions, problems and chapter summaries. May be used along with Physics 11/12 curriculum guide for advanced units.

Heath, Robert W. and others. Fundamentals of Physics. Toronto: Heath Canada, 1978.

Excellent instructional text with easy readability. Good coverage of topics for students with little physics background. May be used along with Physics 11/12 curriculum guide for advanced units.

Michael, Leo. A Basic Math Approach to Concepts of Chemistry. 2nd ed. Monterey, Calif.: Brooks-Cole, 1982.

An excellent self-paced resource for students of basic chemistry. provides many problems with answers and could be used as a supplemental resource for both intermediate and advanced units.

Miller, F. and others. *Concepts in Physics*. San Diego, Calif.: Academic Press, 1980.

Good instructional text for more advanced students. Suitable for use along with Physics 11/12 curriculum guide. Not appropriate for students without previous physics background.

B.C. Ministry of Education. *VAST 3 - Science* - Victoria, B.C.: Curriculum and Program Development Branch, 1976.

This series of 2 workbooks contains material designed for individualized instruction. The topics include a basic introduction to the fields of Biological and Physical Science. The series contains some good practical teaching materials which could be adapted for several intermediate units in this guide.

B.C. Ministry of Education. *VAST 4 - Biology; Chemistry; Physics*. Victoria, B.C.: Curriculum and Program Development Branch, 1977.

This series consists of 3 workbooks, each one focussing on a particular field of science. It is designed for individualized instruction. Each books contain materials which could be adapted or used "as is" to enhance several of intermediate or advanced units of this guide.

B.C. Ministry of Education. *Operations of Science*. (Ed. Geoffrey A. Dean), Victoria, B.C.: Program Research and Development Branch, 1979.

These two resource books (Student-Workbook and Instructor's Guide) contain a collection of 18 small Group Activities designed for use in a continuous intake, self-paced ABE program. The approach is to teach scientific methods and processes rather than scientific facts. Several of the activities could be adapted or used "as is" to enhance several of the fundamental and intermediate units in this curriculum guide.

INSTRUCTIONAL RESOURCES: AUDIOVISUAL

The following is a selected list of audiovisual resources to support the ABE Science course. Titles, PEMC catalogue numbers, film length and brief annotations are listed alphabetically under these categories:

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General Science	255
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Environmental Management	262
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Most of these and many other A/V resources are available through the Provincial Educational Media Center (PEMC). In addition to its comprehensive catalogue, PEMC recently published an annotated list of resources suitable for Junior Secondary Science (1983). Instructors will also find useful the various TV and radio series such as *Ascent of Man*, *Cosmos*, *Nature of Things*, *Quirks and Quarks*. Knowledge Network of the West (KNOW) also presents a number of excellent science programs.

GENERAL SCIENCE

Dr. Epstein Talks About Chemicals in the Workplace NFB #106C 0178 531 Colour 9 mins.

Dr. Epstein Talsk About Distortion of Information NFB #106C 0178 532 Colour 13 mins.

Two safety related films.

An Easy Pill to Swallow NFB #106C 0178 341 Colour 30 mins.

A documentary in dialogue form, presenting the case both for and against drugs from the viewpoint of doctors and patients.

Feelin' Great NFB #106C 0173 665 Colour 22 mins.

Explains the human body's need for exercise and the sense of well-being that comes from physical activity.

Heart Attack - Prescription for Survival NFB #106C 0180 146 Colour 56 mins.

Provides a detailed account of the kinds of people who are most likely to be victims of heart disease. Examines work of cardiologists and the possibilities of artificial hearts.

One Way to Quit CBC #106C 1076 232 Colour 56 mins.

Discusses the consequences of smoking.

Think Before You Eat CBC: Nature of Things #106C 1076 167 · Colour 28 mins.

A look at why more people in Canada die from overeating rather than too little food.

Stress NFB #106B 0156 013 B & W 10 min.

An early documentary study with Hans Selye.

The Unplanned NFB #106C 0171 56B Colour 20 min.

An industrial accident prevention film which illustrates basic accident prevention rules.

(The above three films are all safety related films.)

BIOLOGY

Beyond the Naked Eye NFB #106C 1073 035 Colour 18 mins.

A look at life forms in a single drop of water taken from a fish aquarium.

Butterflies, Beetles and Bugs NFB #106C 0161 078 Colour 17 mins.

An introduction to the study of classification, through the exploration of the insect world.

The Colour of Life NFB #106C 0155 009 Colour 24 mins.

Using both time-lapse photography and animated diagrams, the maple leaf and segments of the tree serve as illustrations of the physiological processes that go on in all plants.

Darwin CBC #106C 0176 269 Colour 25 mins.

This film is about the life and theories of Charles Darwin. The controversy of his thinking which pitted science against church is explained. This is a good illustration of the life and work of a scientist.

D.N.A. NFB #106C 0168 174 Colour 11 mins.

The genetic material DNA is described and illustrated.

Down To the Sea NFB #106C 0172 645 Colour

Looks at the work done by marine scientists and the technological equipment used to collect their data. This film might be used to illustrate the definition and scope of science.

The Differences are Inherited CBC #106C 0176 064 Colour 28 mins.

David Suzuki uses the example of fruit-fly to discuss mutations, current genetic research and the relationship of genetic research to some of the problems suffered by human beings.

The First Inch CBC #106C 0176 168 Colour 28 mins.

A exploration of the cycles and systems in the microscopic world in which dead sustains the living and keeps cycles in motion.

Keepers of Wildlife NFB #106C 0172 557 Colour

Looks at the work done by scientists in the preservation of dwindling wildlife species.

Microscopic Fungi NFB #106C 0160 007 Colour 17 mins.

Illustrates the world of fungus growth and how these micro-organisms spread and reproduce. Also illustrates their many useful functions.

New Alchemist NFB #106C 0174 157 Colour

Explores different points of view of science and its application, by a group of people living on a farm who are trying to connect the various life sustaining systems to one another.

Nature's Food Chain NFB #106C 0177 148 Colour 13 mins.

Explains the nature, parts and functions of the food chain.

The Water's Edge: The Unseen World CBC #106C 0176 061 Colour 28 mins.

The Water's Edge: The Silent Explosion CBC Nature of Things #106C 0176 060 Colour 28 mins.

A two-part series about life in a fresh water pond.

What is Life? NFB #106C 0170 013 Colour 8 mins.

A description of what biophysics and biochemistry now perceive as the facts of life concerning evolution and the genetically determining factor of the DNA molecule.

EARTH SCIENCE

The Long View NFB #106C 0162 005 Colour

A look at some of the practical applications of Canada's activity in the field of space technology, including application of science to the management of natural resources and the environment.

Riches of the Earth NFB #106C 0166 019 Colour

Through the use of animation the formation of the earth's crust and its mineral wealth is depicted. The film shows how geological ages, fire, water, wind and ice helped to produce minerals, oil, coal, arable land and water power.

Satellites of the Sun NFB #106C 0174 158 Colour

A detailed look at the solar system.

Solar Energy: Towards the Sun CBC Nature of Things Colour 28 mins. #106C 0178 484

Explains the use of solar energy to heat and cool homes, and to drive the wheels of industry. Details some experiments being carried out in Canada and the U.S.A.

This is an Emergency NFB #106C 0179 750 Colour 29 mins.

Focuses on the need for Canada to develop sources of fuel other than oil to maintain a secure economy. David Suzuki narrates.

Nuclear Power CBC #106C 0178 472 Colour 28 mins.

A study of a complex technology which may prove expensive and hazardous to the future of the world.

Nuclear Fuel - Waste Research (The Canadian Program) #106C 0179 607 Colour 24 mins.

People working inside and outside the nuclear industry discuss and explain the Canadian program for nuclear fuel waste management.

ECOLOGY

The Biosphere NFB #106C 0179 085 Colour 57 mins.

A look at two of the world's myriad river ecosystems (Amazon and Mackenzie) and how they are linked within the biosphere.

Above the Timberline: The Alpine Tundra Zone NFB #106C 0160 004 Colour 16 mins.

A look at the high peaks of the world where only the most tenacious of living things endure.

The Chiricahaus CBC Nature of Things #106C 0180 098 Colour 28 mins.

Chiricahaus mountains of southeast Arizona present a classic example of altitudinal zoning.

The Changing Forest NFB #106C 0158 010 Colour 18 mins.

A brief essay on the ecology of a forest area of the type found along the southern fringes of the Laurentian Shield.

The Edge of the Barrens NFB #106C 0164 006 Colour 14 mins.

An excellent film study of Canada's sub-arctic tundra region.

High Arctic NFB #106C 0159 058 Colour 11 mins.

A record of the struggle for life within the Arctic circle.

High Arctic NFB Life on Land #106C 0158 035 22 mins.

An ecological study of the plant and animal life on the Queen Elizabeth Islands in the Canadian Arctic.

The Desert CBC Nature of Things #106C 0176 227 Colour 28 mins.

A look at the wide variety of plants and animals who have made the desert their home.

The Invisible Reef CBC Nature of Things #106C 0177 019 Colour 28 mins.

Explains how a coral reef is formed and perpetuated by a complex system of recycling that makes use of all available energy and materials.

Island of Monkeys CBC #106C 178 458 28 mins.

Looks at the Rhesus monkeys brought from India to a tiny island off Puerto Rico.

The Sea NFB #106C 0171 538 Colour 29 mins.

Shows the sea and not the continents as the dominant force of the planet. Explores the work of scientists engaged in oceanographic research.

The Spruce Bog NFB #106C 0157 004 Colour 22 mins.

Examines the conditions under which a spruce bog is formed, detailing the types of plant life found at different stages of succession from open water to mature spruce forest.

Temples of Time NFB #106C 0171 002 Colour 43 mins.

The atmosphere is a living thing with its own ecological balance but also subject to the ravages of man's technology.

Trout Stream NFB #106C 0161 008 Colour

A study of the eastern brook trout.

ENVIRONMENTAL MANAGEMENT

The Garbage Ouroboros CBC Nature of Things #106C 0175 209 Colour 28 mins.

A look at a sophisticated recycling and reprocessing industry developed by scientists and technologists.

Forecast for Survival NFB #106C 0175 555 Colour 18 mins.

Examines a computer technique being used to predict the movement of oil slicks and the benefits for emergency clean-up crews.

Man the Polluter NFB #106C 0173 107 Colour 54 mins.

An animated film which examines man's capacity to ignore the state of pollution.

Tanker bomb CBC #106C 0178 434 Colour 57 mins.

Outlines the possible disasters that might occur to Canada's coastlines due to the increased tanker traffic if steps toward prevention are not taken.

When the Wind Blows CBC #106C 0177 305 Colour 28 mins.

Explores the complexities of windpower, its current and potential uses.

HEALTH

Acupuncture CBC Nature of Things #106C 0176 295 Colour 27 mins.

Explores acupuncture as it has evolved through history and as it takes its place in modern medical science.

Cancer in Women NFB #106C 0174 050 Colour 16 mins.

A film designed to convince women of the need for regular physical check-ups to detect and counter early symptoms of cancer.

Contraception: The Hidden Cost CBC Man Alive #106C 0178 056 27 mins.

Modern contraception is presented in this film not only as a technique but also as an attitude to living. Counsellors and couples discuss various methods and their implications.

Left Brain - Right Brain CBC Nature of Things #106C 1079 295 Colour 51 mins.

Research confirms that the two halves of the human brain tend to specialize in different ways of thinking and perceiving.

Memory - Come to Think of It CBC Nature of Things #106 0179 233 28 mins.

Explores the memory storage system, which has mystified and puzzled scientists for centuries.

Mind and Hand CBC #106C 0174 203 Colour 28 mins.

Explores the question, "What happens when a person makes a voluntary movement?" In an attempt to answer the question, scientists are studying electrical impulses that originated in the brain and are then transmitted via nerve channels to the muscles.

One-Two-Three-Zero CBC Nature of Things #106C 0179 306 Colour 38 mins.

Describes the methods used in the birth of the first "test-tube" baby.

Patterns of Pain CBC #106C 0178 430 Colour 28 mins.

Explores the perception of pain in the human nervous systems and describes several techniques used to alleviate pain.

Question of Immunity NFB #106C 0171 034 Colour 13 mins.

The manner in which the human body's defences identify and reject intruders is not yet fully understood. With the help of photomicrograph and animation some of the known facts are illustrated.

Radiation: In Sickness and in Health CBC #106C 0178 469 Colour 28 mins.

Explores the beneficial applications of radiation and explains how it has been used in medicine for therapy and diagnosis since the time of its discovery.

PHYSICS

Continuum NFB #106C 0179 118 Colour 46 mins.

An introduction to Einstein's special theory of relativity.

The Vision of Galileo CBC Nature of Things #106C 0180 112 Colour 28 mins.

In a script based mainly on Galileo's own writing, many of his experiments are repeated and explained.

SCIENCE PERIODICALS

American Scientist
Subscription Dept.
345 Whitney Avenue
New Haven, C.T. 06511

Astronomy
Astro Media Corp.
411 E. Mason Street
P.O. Box 92788
Milwaukee, WI 53202

Audubon
National Audubon Society
Membership Department
950 Third Avenue
New York, NY 10022

B.C. Science Teacher
B.C. Teachers' Federation
2235 Burrard Street
Vancouver, B.C.
V6J 3H9

Consumer Reports
Consumer Reports
Subscription Director
P.O. Box 1949
Marion, Ohio 43305

Discover
Time Inc.
3435 Wilshire Boulevard
Los Angeles, Calif. 90010

Forestalk
Province of B.C.
Ministry of Forests
Information Services Branch
1450 Government Street
Victoria, B.C. V8W 3E7

Nature Canada
Canadian Nature Federation
Magazine Services
75 Albert Street #203
Ottawa, Ontario K1P 6G1

Science 83
Science 83
Subscription Department
P.O. Box 10790
Des Moines, Iowa 50340

Science Digest
Science Digest
P.O. Box 10076
Des Moines, Iowa 50350

Science Dimension
National Research Council of
Canada
Ottawa, Ontario K1A 0S2

Science News
Science News
Subscription Department
231 West Center Street
Marion, Ohio 43302

Science Teacher
National Science Teachers
Association
1742 Conneticut Ave. N.W.
Washington, D.C. 20009

Science & Technology
Science and Technology
Subscription Dept.
48 East 43rd Street
4th Floor
New York, NY 10017

Science World
Science World
Office of Publication
2280 Arbor Blvd.
Dayton, Ohio 45439

SciQuest
Subscription Services Dept.
P.O. Box 998
Farmingdale, N.Y. 11737

Space World
Amherst Press
Amherst, WN 54406

Wildlife Review
Province of British Columbia
Ministry of Environment
Parliament Buildings
Victoria, B.C. V8V 1X5

PROFESSIONAL REFERENCES

Anderson, H., and P. Koutnik. Toward More Effective Science Instruction in Secondary Schools. New York: Mcmillan, 1972.

Anderson, Roger. The Experience of Science - A New Perspective for Laboratory Teaching, New York: Teachers College Press, 1976.

Bachert, R., and E. Snooks. Outdoor Education Equipment: Plans for East-to-Make Items. Danvill, Ill.: Interstate, 1974.

Bolton, W. Patterns in Physics. New York: McGraw Hill, 1974.

Brandwein, P.F., and others. Sourcebook for the Biological Sciences, 1966.

British Columbia. Ministry of Education. Junior Secondary Science - Curriculum Guide and Resource Book. Victoria: Publication Services, 1983.

An excellent resource. Integrated science curriculum for B.C. Schools Grade 8, 9 and 10.

______________________________. Introduction to Teaching Adults. Victoria: Post-secondary Department, Continuing Education Div.: 1981. (Order from UBC Centre for Continuing Education).

Excellent resource for instructors who have little or no experience with adult students. Complete program consists of eleven modules each comprised of a small booklet and an audio cassett. Can be used as a resource or an independent study program for credit toward Instructors' Diploma Program Course 101 at UBC.

Curriculum Guides - Division of Educational Programs, Schools Curriculum Branch, Victoria, B.C. (Order from Publication Services, Victoria).

Biology 11/12, 1974.
Chemistry 11, 1977.
Chemistry 12, 1978.
Earth Science, 1977.
Geology 12, 1977.
Physics 11/12, 1981.

Product Information Guides. Victoria: Publication Services Branch (free list of recommended resources)

Product Information, Physics 11, 1981.
Product Information, Physics 12, 1982.

Brooke, W. Michael (Ed.). Adult Basic Education - A Resource Book. Toronto: New Press, 1972.

Brundage, Donald H. and MacKeracher, Dorothy. Adult Learning Principles and Their Application to Program Planning. Toronto, Ontario Institute for Studies in Education, 1980.

Clarke, Donald (Ed.). ENERGY: A How It Works Book. New York: Arco, 1978.

Good instructor reference to energy topics.

DeCoursey, R.M., and J.L. Renfro. The Human Organism. New York: McGraw-Hill, 1980.

Provides good background in human anatomy and physiology.

Dickinson, Gary. Teaching Adults: A Handbook for Instructors. Toronto: New Press, 1973.

Excellent resource for instructors of adults.

Dusek, Dorothy and D.A. Girdan. Drugs: A Factual Account. Reading, Mass.: Addison-Wesley, 1980.

Good instructor resource. Factual information as well as discussions on the social and legal impacts of drugs on society, the effects of certain drugs on the body and their relationship to behaviour modification.

Epstein, L.C., and P.G. Hewitt. Thinking Physics: Questions and Conceptual Explanations. San Francisco: Insight Press, 1981.

Excellent resource for topics in mechanics, fluids, heat and vibrations. Explains "why things work".

Faughn, Jerry S. and Karl F Kuhn. Physics for People Who Think They Don't Like Physics. New York: Holt, Rinehart and Winston, 1976.

Good resource material for many intermediate physics units or as an alternate instructional resource.

Furdek, Patricia. *Microcomputer Courseware Review of Software Suitable for Use in Adult Basic Education.* Victoria: Ministry of Education, Continuing Education, 1982.

A useful resource for instructors.

Gagne, Robert M. *The Conditions of Learning*. New York: Holt, Reinhart and Winston, 1977.

A good resource for those new to the profession of teaching or wanting more background on the theories of learning.

Gale, George. *Theory of Science - An Introduction to the History Logic and Philosphy of Science*. Toronto: McGraw-Hill, 1979.

Gronlund, N.E. *Constructing Achievement Tests.* Englewood Cliffs, N.J.: Prentice-Hall, 1977.

Harris, Norman, and Edwin M. Hemmerling. *Introductory Applied Physics*. New York: McGraw-Hill, 1980.

Hawley, G.G. (Ed.) *The Condensed Chemical Dictionary*. New York: Van Nostrand Reinhold, 1981.

An excellent reference of chemicals, raw materials, processes terminology and trademarked products.

Hewitt, P.G. *Conceptual Physics; A New Introduction to Your Environment*. Boston: Little, Brown, 1981.

Excellent resource for instructors with little or no background in physics.

Houle, C.O. *The Design of Education*. San Francisco: Jossey-Bass, 1972.

Good professional resource for new instructors.

Joseph, Alexander, and others. *Teaching High School Science: A Sourcebook for the Physical Sciences*. New York: Harcourt Brace Jovanovich, 1961.

A standard reference for all instructors of science.

Kapit, Wynn, and Lawrence M. Elson. *The Anatomy Coloring Book*. New York: Harper and Row, 1977.

Over 140 detailed large and small scale diagrams of human anatomy, suitable for student or instructor use at any level. Detachable pages.

Keeton, William T. *Biological Science*. New York: W.W. Norton, 1980.

Good reference providing a comprehensive and integrated coverage of biology.

Kidd, J.R. *How Adults Learn*. New York: Association Press, 1973.

A good instructor reference for those beginning to teach adults.

Knox, Alan B. "Helping Adults to Learn." In *Yearbook of Adult and Continuing Education (1978-79)*. Chicago, Marquis Academic Media, 1978.

Knowles, M.S. *The Modern Practice of Adult Education: Andragogy versus Pedagogy*. Chicago: Follett, 1980.

Good professional resource for in adult education.

Liska, Ken. *Drugs and the Human Body: With Implications for Society*. New York: Macmillan, 1981.

The history, facts and effects of drugs on the body. Good coverage of topics.

Marshall, J.S., and others. *Physics*. Macmillan of Canada, 1967.

Good basic general physics text for those requiring extra physics background.

Mohart, E., and others. *A Sourcebook for the Biological Sciences*. New York: Harcourt Brace, 1958.

A standard resource for all science instructors.

Malaspina College Microcomputer Orientation Manual: An Introduction to the Apple Microcomputer for Adult Basic Education Instructors. Victoria: British Columbia, Ministry of Education, 1981.

A handy reference for those with no computer experience.

Rogers, E.M. Physics for the Inquiring Mind. Princetown, N.J.: Princeton University Press, 1973.

Sackheim, George, and Dennis Lehman. Chemistry for the Health Sciences. New York: Macmillan, 1981.

Good coverage of specific topics related to the health sciences, radioactivity, redox, liquids, acid bases, salts, alcohols, lipids, proteins, enzymes.

Siebert, Eleanor D. Foundations of Chemistry. New York: McGraw-Hill, 1982.

Resource for those with little or no chemistry background.

Smith, Alpheus, and J.N. Cooper. Elements of Physics. New York: McGraw-Hill, 1979.

Resource for those requiring more background in physics.

Stark, Edward C. Essential Chemistry. Encino, California: Glencoe, 1979.

Good general reference for those with little or no chemistry background.

United National Educational, Scientific and Cultural Organization. New UNESCO Source Book for Science Teachers. New York: United Nations, 1973.

University of British Columbia. Continuing Education Centre. Instructors Diploma Course #104: Evaluation of Student Progress. Vancouver, B.C.: UBC Continuing Education Centre.

Vander, Arthur, and others. Human Physiology. New York: McGraw-Hill, 1980.

Good reference for human biology topics.

Verner, Coolie, and Cathy Davison. Psychological Factors in Adult Learning and Instruction. Tallahassee: Florida State University Adult Education Center, 1971.

Walker, J. The Flying Circus of Physics with Answers. New York: Wiley, 1977.

A good resource to "start you thinking about physics when you are cooking, flying or just lazing next to a stream."

Watland, Merrill. Composition of Foods - Raw Processed and Prepared. Agriculture Handbook #8, Washington, D.C., U.S. Dept. of Agriculture, 1975.

Extensive reference on the nutrient value of common foods.

Winter, Ruth. A Consumer's Dictionary of Food Additives. New York: Crown, 1978.

Excellent resource in layman's terms of the harmful and desirable ingredients found in packaged foods.

Zuidema, George, D. (Ed.) John Hopkins Atlas of Human Functional Anatomy. Baltimore: John Hopkins University Press, 1980.

Excellent resource for human biology topics.

STARTER LIST FOR A SMALL SCIENCE MINI-LIBRARY

Bova, Ben. *Man Changes the Weather*. Addison-Wesley, 1973, $5.00.

Discusses harmful and beneficial as well as intentional and unintentional changes.

Branley, Franklyn M. *Black Holes, White Dwarfs and Superstars*. New York: Harper Row, 1976, $8.00.

Latest theories in readable language.

Cousteau, Jacques. *The Act of Life*. World Publishers, 1979, $8.00.

Reproduction using marine examples. One of an excellent series: The Ocean World of Jacques Cousteau).

Farrington, Benjamin. *What Darwin Really Said.* New York: Schocken, 1982, $4.00.

Also what he didn't say! Introduction to Darwinian evolution.

Francis, Peter. *Volcanoes*. Pelican, 1976, $5.00.

Plate tectonics, eruptions, volcanic rocks effect on man, prediction. Not too technical for good readers.

Hall, Alan. *Wild Foods Trail Guide*. New York: Holt, Rinehart and Winston, 1976, $5.00.

Describes plants and uses general and specific. Line drawings, includes appendix of poisonous plants (More general than Euell Gibbons books which are eastern).

Heintze, Carl. *The Biosphere*. New York: Lodestar 1977, $7.00.

Earth, air, fire and water, ice, cycles, zones and pollution all discussed in readable terms.

Horstein, Reuben A. *The Weather Book*. Ottawa: Canadian Government Publishing Centre, 1980, $8.00. (Cat. #56-48/1080 E)

Everything you ever wanted to know about weather - causes, prediction and control.

Mohr, Charles E., and T. Paulson. The Life of the Cave. Chicago: World Book, 1966, $6.00.

Excellent diagrams and photos. Rather like Time-Life books but more readable. Other books in the series deal with seashore, desert and marsh.

Rey, H.A. The Stars: A New Way To See Them. Houghton-Mifflin, 1976, $7.00.

Large charts of seasonal skies, individual constellations, easy reading.

Rue, Walter D. Weather of the Pacific Coast. Vancouver: Gordon Soules, 1978, $6.00.

Explains Pacific coast weather phenomena and why they are so unpredictable.

Sloane, Eric. Eric Sloane's Weather Book. New York: Dutton, 1977, $5.00.

Good on basics although no material on satellites. Easy to read.

Smith, Linwood. Living Shores of the Pacific Northwest Search (Seattle), 1976, $10.00

Well illustrated colour plates and drawings, examples are Washington but apply to much of B.C. coast. Scientific and common names are given. Treats areas by type of habitat.

Snively, Gloria. Exploring the Seashore (B.C. Washington and Oregon). Gordon Soules, Vancouver, 1978, $12.00. Includes vascular plants and mammals associated with the intertidal zone as well as usual algae and invertebrates. Maps, line drawings and colour photos.

Sparkes, John, and Tony Soper. Owls. New York: Tarplinger, 1976, $6.00.

Most books on genus of birds are on exotics. This covers genus well represented in B.C. Photos, anecdotes and excellent natural history.

Vergara, William C. Science in Everyday Life. New York: Harper and Row, 1980, $13.00.

More expensive but good value. Well illustrated. Explains scientific ideas behind simple things.

Volcano: The Eruption of Mt. St. Helens. Longview, Wash.: Madrona, 1980.

Traces history of recent eruption. Well illustrated. Probably the best of a number of books on the subject.

Whitney, Charles A. *Whitney's Starfinder*. New York: Knopf, 1982, $7.00.

Includes adjustable starguide. Notes on planets, eclipses, constellations, etc.

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We would like to have the responses by March 31, 1984 so that any changes may be included in the formal edition to be published soon after.

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